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Ser. X.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

Vol. I.

Pt. i, 1874.—RHINOCEROS DECCANENSIS.—By R. B. FOOTE, F.G.S., *Geological Survey of India.*

Pt. ii, 1876.—MOLAR TEETH AND OTHER REMAINS OF MAMMALIA;

Pt. iii, 1878.—CRANIA OF RUMINANTS;

Pt. iv, 1880.—SUPPLEMENT TO CRANIA OF RUMINANTS;

Pt. v, 1880.—SIWALIK AND NARBADA PROBOSCIDIA.—By R. LYDEKKER, B.A., *Geological Survey of India.*

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INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

Vol. I.

PREFACE.

In completing this first volume of the series of the "Palæontologia Indica," entitled "Indian Tertiary and Post-Tertiary Vertebrata," I avail myself of the opportunity afforded of making certain corrections and additions, which subsequent investigations have rendered necessary, in regard to some of the descriptions. I may mention that at the time of publication of the second fasciculus, there were contained in the Indian Museum only very fragmentary remains of many species, now represented by a much larger and more complete series: by the help of these more ample materials, I am now enabled in several cases to correct certain errors into which I had previously fallen. I may further add that had I had any idea, at the time of publication of that fasciculus, that the Indian Museum was at all likely to obtain such a magnificent collection of Siwalik vertebrate fossils as now enrich its cases, I should not have described remains of different orders in the heterogeneous manner in which they are there placed, but should have devoted a fasciculus to each order or sub-order, as has been subsequently done.

I cannot but regret that the execution of many of the plates in the second and third fasciculi is so poor; it was, however, the best that could be done at the time. A change in our arrangements has produced better results in the last fasciculus. Three of the worst of the earlier plates have been reissued with the fourth and fifth fasciculi.

In the references given below, and also in the index to the volume, the number of the pages refers to the continuous paging of the volume, and not to the separate paging of the five component parts.[1] The plates, with the exception of the first three, have the same heading, "Tertiary Mammalia," as forming one continuous series of illustrations of mammalian remains. The measurements given in this volume are all in inches and tenths.

[1] In the first fasciculus, there is of course only one system of paging; in the second, the volume numbering is at the bottom of each page; and in the succeeding parts, on the outer side of the part numbering.

The first fasciculus of this volume bears a different serial title from the succeeding fasciculi; this discrepancy is owing to the circumstance, that at the time of the publication of the first fasciculus, there was no idea entertained that the Indian Museum was likely to acquire the large collection of Siwalik fossils which are now exhibited in its cases.

In the introductory remarks to the second fasciculus, it was stated that the fourth fasciculus would be devoted to the description of the remains of Carnivora, and that a classified synopsis of the fossil Mammalia of South-Eastern Asia would be appended. Since the publication of the second fasciculus the collection of fossil Proboscidia in the Indian Museum has increased to such an unexpected extent, that it has afforded ample materials for a large fasciculus of itself: the collection of fossil Carnivora, on the other hand, is still very imperfect, and its description has accordingly been postponed: the publication of the synopsis has likewise been deferred.

No strict systematic arrangement has been adopted in the second, third, and fourth fasciculi, many of the specimens having been obtained while the work was still in progress, and described out of their proper serial succession: in the fourth fasciculus the same arrangement of the ruminants has been adopted as in the third, for convenience of reference. Similarly in the lists of ruminants given on pages 92 and 180, the same grouping has been adopted: the reader will understand, therefore, that the arrangement in those lists is in no wise a systematic one. in a systematic list the goats and sheep would of course be placed with the other *Cavicornia*. In the last fasciculus, where the materials were all at hand at the commencement of the work, a strictly systematic arrangement has been adopted.

Rhinoceros deccanensis.—Professor Flower[1] classes this species under the generic, or sub-generic, division *Atelodus*, in which are included the living *R. bicornis* and *R. simus* of Africa, and the fossil *R. pachygnathus*, *R. etruscus*, *R. leptorhinus*, *R. hemitœchus*, and *R. tichorhinus* of Europe. The lower jaw figured in Plate LXXIV, fig. 6, of the " Fauna Antiqua Sivalensis," under the name of *R. sivalensis*,[2] seems also to indicate an animal belonging to the same group.

Narbada Rhinoceros.—A recent re-examination of the two upper molars of a rhinoceros from the pleistocene rocks of the Narbada valley, figured on Plate IV, figs. 5 and 6, of this volume, and described on page 32 under the name of *Rhinoceros namadicus*,[3] has convinced me that these teeth are specifically indistinguishable from those of the living *R. indicus*, the very slight differences which I pointed out as existing between the recent and fossil last molars not being more than individual varieties. If, therefore, the similarity in the teeth can be relied on, we

[1] Proc. Zool. Soc., 1876, p. 457.

[2] Although in the text I have adopted Falconer's determination of the lower jaws of the Siwalik Rhinocerotes, I am quite unacquainted with the grounds on which such determinations were made.

[3] The name *R. namadicus* of Falconer occurs in the introduction to the " Fauna Antiqua Sivalensis" (Pal. Mem., Vol. I, p. 21), and was, I believe, as stated in the sequel, applied to limb-bones from the Narbada.

have evidence of the existence of *R. indicus* in the pleistocene of India,[1] contemporaneously with the extinct mammals.

I cannot discover the history of the two molars under discussion: when I joined the Geological Survey, they, in company with other fossils, were in the Museum of the Survey and were labelled " Nerbudda valley." Both teeth are in a highly mineralised condition, and the earlier one (fig. 6), is embedded in a block of hard brown clayey sandstone, like many other Narbada specimens; I have therefore no doubt as to their origin.

An ultimate upper molar of *R. indicus* has been obtained by Mr. Foote from the alluvium of Madras, showing, in conjunction with the Narbada specimens, that the former geographical range of the species must have been very extensive.[2]

A right humerus of a fossil rhinoceros from the Narbada, in the collection of the Indian Museum, differs considerably in form from the corresponding bone of *R. indicus*, and would, therefore, seem to indicate the former existence of a second Narbada species. If the species should eventually turn to be distinct, the name of *R. namadicus* might be applied to it: the name is provisionally retained in the list of species of *Rhinoceros* given below, in order to mark the existence of a second Narbada species.

Siwalik Rhinocerotidæ.—Since the publication of the second fasciculus of this volume, in which the teeth of the Indian fossil species of *Rhinoceros* were treated of, as far as my materials then went, Professor Brandt[3] has published a synopsis of the living and fossil species of *Rhinoceros*, in which he has arrived at conclusions, which appear to me unaccountable, in regard to Falconer's three species of Siwalik *Rhinoceros*. On page 39 of that memoir, *R. sivalensis* and *R. palæindicus* are considered as being specifically identical with *R. indicus* (*unicornis*); no reasons, however, are given for this union of the three species, except a vague remark of the late Mr. Blyth, to the effect that there is a great resemblance in the form of the skulls of the three forms. Professor Brandt appears to have entirely overlooked the characters of the molars of the three species. The molars of *R. indicus* are characterized by their complex structure, that is to say, they are furnished with a "combing-plate" and a " crochet," or, in other words, the second main internal column is connected with the outer wall of the tooth by a continuous ridge of enamel, and when the tooth becomes worn there are at least three islands, or fossettes, on the crown: further, the external surface of the tooth runs nearly parallel to the long axis of the crown and is not produced into a buttress at the antero-external angle. The three fossettes on the worn crown are situated nearly

[1] A single upper molar in the Indian Museum, collected by Mr. Hacket in the Narbada deposits, is indistinguishable from the corresponding tooth of the living *Cervus (Rucervus) duvaucellii*, indicating the existence of another living mammal in the pleistocene.

[2] I regret that the execution of the figures of the Narbada specimens is so defective, not giving at all a fair idea of their form.

[3] Mem. de l'Acad. Imp. des. Sci. de St. Pet., Ser. VII, Vol. XXVI, No. 5.

in the same line, and parallel to the antero-posterior axis of the crown. In *Rhinoceros sivalensis,* on the other hand (as is well shown in the upper molar figured in Plate V, fig. 5 of this volume), there is no combing-plate, and the crochet is quite unconnected with the outer wall of the tooth; consequently when the tooth is worn down, there are normally not more than two fossettes[1] on the crown (as is well shown in fig. 5 of Plate LXXIV of the "Fauna Antiqua Sivalensis"), while the antero-external angle of the tooth is produced into a large buttress (shown well in my figure). The teeth of *R. sumatrensis* are of the same type, but that species is distinguished from *R. sivalensis* by having two horns in place of one horn.

The true molars and premolars of *R. palæindicus* (I am here doing little more than repeating the matter given in the text of this volume), likewise never have a combing-plate (though from specimens lately acquired by the Indian Museum, as well as from the young skull represented in fig. 1 of Plate LXXIV of the "Fauna Antiqua Sivalensis"), it appears that the milk-molars are, at all events sometimes, furnished with one. In the adult dentition (as is shown in fig. 2*a* of Plate LXXIV of the "Fauna Antiqua Sivalensis") there are normally three fossettes on the worn crown of each tooth, at some period of its wear: these three fossettes are not, however, placed in the same antero-posterior line, as in *R. indicus,* but the middle one is placed somewhat externally to the other two ("Fauna Antiqua Sivalensis", Plate LXXIV, fig. 2*a*, Plate LXXV, fig. 1), being cut off from the end of the main valley, and not from the hinder side of it. Finally, there is no distinct buttress in the true molars of *R. palæindicus* ("Fauna Antiqua Sivalensis," Plate LXXIV, fig. 2*a*) as in *R. sivalensis,* the outer surface of each molar being nearly flat in the former species. In treating of *Rhinoceros palæindicus* at page 24 of this volume, I noticed a young cranium of that species, which is figured in the "Fauna Antiqua Sivalensis" (Plate LXXIV, fig. 1), and of which there is a cast in the Indian Museum. In noticing this cranium in the description of the plate, Dr. Falconer observes: "Very perfect specimen of cranium with both zygomatic arches entire. Shows two molars and two posterior premolars on either side. The third molar is still in germ." From the mention of premolars by Dr. Falconer, it is quite evident that he considered the specimen as showing the permanent dentition, and in my notice of the cranium, I naturally followed this identification. If, however, we refer to the figure of the cranium in question in the "Fauna Antiqua Sivalensis," we shall see that the last tooth is less worn than the third, or any of the preceding teeth. On Falconer's supposition, the third tooth, being the first true molar, should have been more worn than the second tooth, or last premolar. Again, had the second tooth been the last premolar, and being as much worn as it is, the last true molar would have been in use; further, the first tooth is quite unlike a second premolar. From the above, it will be quite evident that the four teeth in Falconer's cranium really are the four milk-molars. There is therefore no abnor-

[1] A broken skull, probably belonging to this species, in the Indian Museum shows three fossettes on the two middle premolars, but none on the true molars or last premolar.

mality in the dental series of this species, as was the case according to Dr. Falconer's supposition, and the permanent dental formula given on page 24 must now be made to stand as follows[1] :—

$$I. \frac{0-0}{1-1} \quad C. \frac{0-0}{0-0} \quad P. \frac{3-3}{3-3} \quad M. \frac{3-3}{3-3}$$

The table of measurements of the molars will also require the alteration of their names, and will read as follows :—

	In.
Length of 1st milk-molar	1·10
„ of 2nd „	1·65
„ of 3rd „	1·90
„ of 4th „	2·20
Width of 1st milk-molar	0·89
„ of 2nd „	1·50
„ of 3rd „	1·85
„ of 4th „	1·90

Professor Brandt, in identifying *R. sivalensis* with *R. palæindicus*, overlooks the above differences in the dentition, as well as the differences in the crania. *R. sivalensis* ("Fauna Antiqua Sivalensis," Plate LXXIII, fig. 2*a*) has the summit of the occiput and parietals raised to a much higher point than in *R. palæindicus* (*Ibid.*, fig. 1*a*) ; the interval between the nasals and maxillæ is much narrower in the former than in the latter ; *R. palæindicus* is further distinguished by its broader forehead. Both species agree in being unicorn.

On page 44 of the same memoir, Professor Brandt classes the Siwalik *R. platyrhinus* with *R. sumatrensis*, in the genus, or sub-genus *Ceratorhinus* of Gray, apparently merely on the grounds that both species were furnished with two horns. Now, the molars of *R. platyrhinus* are of the complex type (as is explained in the text) of *R. indicus* and *R. tichorhinus*, and not of the simple type of *R. sumatrensis*. The descriptions given in the text will amply show the distinctness of the two species above mentioned, and there are now additional materials in the Indian Museum which still further illustrate the dentition of the fossil species, and which I hope to bring to notice on a future occasion. As evidence apart from the upper molars, the occurrence of three distinct forms of mandible of *Rhinoceros* (apart from *Acerotherium perimense*, which is also represented in the Indian Museum) in the Siwaliks, proves the existence there of three species, although their references to the three named species by Falconer (which I have accepted in the text) is very probably open to doubt. I have shown that *R. platyrhinus*, as regards its dentition, is nearest to *R. indicus*, and *R. sivalensis* to *R. sumatrensis*, which is precisely the reverse of the, what I cannot but call, arbitrary identifications of Professor Brandt. If characters like those of the teeth described in the sequel are to be completely ignored, both Zoology and Palæontology together would be impossible, and all the species of a genus might as well receive a single name. Professor Brandt

[1] The first milk-molar, which often persists, is not counted here in the permanent series.

makes no mention of the somewhat startling instance (according to his identifications) of a Miocene mammal (for *R. sivalensis* lived in the Miocene period in Sind) being identical with a living species, or, in other words, that *R. indicus* is a Miocene species, and was a contemporary of the long extinct *Dinotherium*, *Hyopotamus*, and *Anthracotherium* ; *R. sumatrensis* being also, according to the same author, at least a Pliocene species. As far as I am aware, there are hardly any instances of newer Pliocene mammals being identical with living species, and even by far the greater number of the Pleistocene forms are extinct. I should be inclined to look very doubtfully on such pedigrees for the Indian rhinocerotes even, were they supported by strong evidence, which in the present case is conspicuous by its absence.

The small *Rhinoceros* tooth described on page 46 and drawn in fig. 10 of Plate VI of this volume, as a premolar of an undetermined species, I now think, in all probability, is an anterior milk-molar of *R. platyrhinus*.

In a recently published memoir on the fossil species of *Rhinoceros* and the allied families,[1] Professor Cope has placed *Rhinoceros sivalensis* in a distinct genus under the name of *Zalabis*.

This generic distinction is made on the strength of the statement originally made by Falconer, that this species was "hexaprotodont."[2] I have already shown in the text of this volume (p. 53), that the specimens figured in the "Fauna Antiqua Sivalensis" do not support this statement. In that work, there are figured three forms of lower jaws of Siwalik *Rhinoceros*, referred to the three named species, none of which are hexaprotodont, and of which the one referred to *R. sivalensis* has no incisors. None of the skulls of *R. sivalensis* with which I am acquainted show any upper incisors. I cannot, therefore, see that there is any evidence on which Professor Cope's new genus can be supported.[3]

The very different conclusions arrived at by Professors Brandt and Cope in regard to *Rhinoceros sivalensis*, afford subject for the most serious reflexions as to the present conditions under which palæontological research is carried on. In this case we find two eminent palæontologists, with precisely the same materials before them, arriving at the most opposite conclusions; Professor Brandt identifying *R. sivalensis* with a living species, and Professor Cope referring it to an entirely new genus ! The former writer appears to have arrived at his conclusions from neglecting to notice the specific differences pointed out by other workers, while the latter has relied upon alleged differences which have been shown to be unsupported by any kind of tangible evidence. In both cases it was incumbent on the writers to have decidedly refuted all points which militate against their own conclusions, before instituting the sweeping changes which such conclusions involve.

[1] Bull. U. S. Geol. Geog. Surv., Vol. V, p. 232.

[2] Professor Cope reckons the outer lower tusk of *Rhinoceros* as a canine.

[3] I may mention that on page 229 of his above quoted memoir, Professor Cope omits *Acerotherium perimense* from his list of that genus, *Rhinoceros iravadicus* from the genus *Rhinoceros*, and *R. deccanensis* from the genus *Atelodus* ; Professor Cope also alludes to the Siwaliks as being undoubtedly of upper Miocene age !

If the lower jaw assigned to *R. sivalensis* in the "Fauna Antiqua Sivalensis" be rightly assigned, and if we admit the sub-divisions into which the old genus *Rhinoceros* is split up by many modern naturalists, *R. sivalensis* would seem from this point of view to belong to the genus *Atelodus* characterized by the symphysis of the mandible of the adult being edentulous, as in *Rhinoceros simus*. The skull of *R. sivalensis* is, however, unicorn, and, therefore, differs from that of *R. simus*. The species in fact, if the remains are rightly correlated, will not fit into any of the modern sub-divisions of the genus.

Rhinoceros iravadicus.—The fragment of a right maxilla of a species of *Rhinoceros* with two teeth described on page 45, and figured in Plate V, fig. 4, of this volume, which was not specifically determined, and the teeth in which were considered to be premolars, I now find to belong to a young individual with the milk-molar dentition. It appears probable that these milk-molars may have belonged to a young individual of *Rhinoceros iravadicus*, the permanent molars of which species are figured on the same plate: in having a combing plate they are more complex than the true molars.

Acerotherium perimense (*Rhinoceros planidens*).—As I have already mentioned in the "Records,"[1] the two imperfect upper molars of a rhinoceros figured on Plate IV, figs. 7 and 9, and described on page 41 of this volume, as belonging to a new species of *Rhinoceros*, under the name of *R. planidens*, really belong to *Acerotherium perimense* of Falconer and Cautley. The upper teeth of that species figured on Plate VI, figs. 2 and 5, as upper true molars, really are premolars, and the unnamed specimen represented in fig. 6 of the same plate is likewise an upper premolar of the same species.[2] The name of *R. planidens* must accordingly be erased from the list of Asiatic species of *Rhinoceros* given on page 52, and the description of its upper molars be read as those of *A. perimense*. In a subsequent volume I shall hope to illustrate more fully the dentition and craniology of the last named species: a cranium is now in the collection of the Indian Museum. As the teeth of this species, described on page 51 as molars, are really premolars, the statement as to the difference in shape of the molars of this species from the molars of *Rhinoceros* will consequently not stand.

It is at present unknown whether *Acerotherium perimense* was furnished with three or four digits to the forelimb, and from the condition in which Siwalik fossils usually occur, it is very improbable that this point will ever be determined. It is, therefore, impossible to say whether the species really belongs to *Acerotherium* or to the new genus *Aphelops* of Professor Cope,[3] differing from *Acerotherium* in having only three anterior digits. I prefer provisionally to retain the species in the older genus.

[1] Vol. XII, p. 47.

[2] On page 44 I mentioned that I thought it possible this tooth should be referred to *R. planidens (A. perimense)*. The cingulum is remarkably developed in this tooth, and causes it to resemble the premolars of *R. deccanensis*, as noticed in the description.

[3] Bull. U. S. Geol. Geog. Surv., Vol. V, p. 236.

Species of Asiatic Rhinocerotidæ.—I append a few notes on the list of species of *Rhinoceros* given on page 52. Professor Brandt, in his memoir quoted above, admits *Rhinoceros inermis* of Lesson as a distinct species, which should, therefore, be added to the list. Professor Cope, in the above quoted memoir, suggests that this species should be referred to the genus *Aphelops*. Professor Brandt includes under *Rhinoceros javanicus* (*sondaicus*) both *R. nasalis* and *R. floweri* of Gray (the latter species classed as a synonym in my list). By the same writer *R. stenocephalus* of Gray is considered to have been founded on a young individual of *R. indicus* (*unicornis*). Again, under *Rhinoceros* (*Ceratorhinus*) *sumatrensis*, Professor Brandt includes *R. crossii*, *R. blythii*, and *R. niger* of Gray; the two former so-called species were omitted from my list, as being probably synonyms.

The following list of the recent and fossil species of *Rhinocerotidæ* of South-Eastern Asia is given to replace the one given on page 52, as embodying the more recent views. The synonomy of the existing species is given on the authority of Professor Brandt, and is taken from the memoir already cited. The name by which each species has been referred to in this volume is taken as the name of the species. The sub-generic (or generic) divisions of *Rhinoceros* (except *Acerotherium*) have been ignored, as they are, in many cases, inapplicable to the fossils, and the species have been arranged in alphabetical order; synonyms are in italics.

1. Acerotherium perimense (Falc. and Caut.) Mio-Pliocene. India and Burma.
   Rhinoceros perimensis (Falc. and Caut.)
   Rhinoceros planidens (*olim nobis*).
2. Rhinoceros deccanensis (Foote). Pleistocene. India.
3. Rhinoceros indicus (Cuv.) Recent and Pleistocene. India.
   R. asiaticus (Blum.)
   R. namadicus (*olim nobis*).
   R. stenocephalus (Gray).
   R. unicornis (Linné).
4. Rhinoceros inermis (Lesson). Recent. India.
5. Rhinoceros iravadicus (*nobis*).[1] Mio-Pliocene. Burma.
6. Rhinoceros javanicus (Gray). Recent. South-Eastern Asia.
   R. floweri (Gray).
   R. javanus (Cuv.)
   R. nasalis (Gray).
   R. sondaicus (Horsfield).
7. Rhinoceros lasiotis (Sclater). Recent, Mallacca.
? 8. Rhinoceros namadicus (Falc. and Caut.) Pleistocene. India.
9. Rhinoceros palæindicus. (Falc. and Caut.) Mio-Pliocene. India.
10. Rhinoceros platyrhinus (Falc. and Caut.) Mio-Pliocene. India.
11. Rhinoceros sinensis (Owen). ? Pliocene. China.
12. Rhinoceros sivalensis (Falc. and Caut.) Mio-Pliocene. India.
    R. indicus fossilis (Baker and Durand).
13. Rhinoceros sumatrensis (Cuv.) Recent. South-Eastern Asia.
    R. blythii (Gray).
    R. crossii (Gray).
    R. niger (Gray).
    R. sumatranus, (Raffles).

[1] The word *nobis* in this volume always refers to myself, and not to Mr. Foote.

Siwalik Artiodactyla described in 2nd part.—Since the publication of the second fasciculus of this volume, the list of Siwalik suine *Artiodactyla* has been considerably increased, and the list given on page 78 is consequently incomplete: to that list must now be added—

Sus punjabiensis.
Hyotherium sindiense.
Hyopotamus palæindicus.
Sivameryx.
Hemimeryx.
Chæromeryx silistrensis has also turned out to be distinct from *Anthracotherium silistrense.*[1]

Palæoryx.—Two upper molars in the Indian Museum, from the Siwaliks, seem to me to be in all probability generically identical with *Palæoryx* of the Pikermi beds of Attica.[2] I cannot, however, at present be quite certain of this determination, owing to the extreme difficulty of distinguishing the molars of many genera of ruminants.

Portax.—Some upper and lower jaws with ruminant teeth, from the Siwaliks, appear to me generically indistinguishable from those of *Portax*, and indicate a Siwalik representative of that genus.

Portax namadicus (Rüt.). When noticing the additions made by Professor Rütimeyer to the Indian fossil Ruminants,[3] I had not observed the new Narbada species of *Portax* (*P. namadicus*) named by the Professor, from the hinder part of a skull in the British Museum.[4] The addition of this species to the Narbada fauna is of great importance, as connecting the living and Siwalik species.

An atlas of a ruminant in the Narbada collection of the Indian Museum corresponds so exactly with the atlas of *Portax pictus* (except in being slightly larger) that I think it probably belongs to *Portax namadicus*. Two left molars of a ruminant, formerly in the Museum of the Asiatic Society of Bengal, and entered on page 255 of Falconer's catalogue of that collection, as being from the Narbada,

[1] I am now uncertain of the generic distinctness of *Hippopotamodon.*

[2] "Animaux fossiles et Géologie de l'Attique," Plate XLVII.

[3] pp. 178-180.

[4] "Die Rinder der Tertiär-Epoche, &c.," p. 89, Plate VI, figs. 7 and 8. I hope Professor Rütimeyer will pardon me if I mention the inconvenience which arises from first mentioning the name of a new species in the midst of a paragraph, as he has done in this case. The description of every new species ought to have a distinct heading, by which it at once catches the eye. In the case of *Portax namadicus* not at first having time to read Professor Rütimeyer's memoir through, the name of this species, from appearing in the middle of a sentence, did not catch my eye until I had time for a more leisurely perusal of the work. Dr. Gray uses the name *Portax picta* for the living species, which also occurs in a former part of this volume; the Greek word Πόρταξ, a young bovine animal, is, however, either masculine or feminine, and the former gender should have the preference. Hence *Portax pictus*, as given by Jerdon and *P. namadicus*, by Rütimeyer, are correct.

and doubtfully referred to the genus *Cervus* (No. N, 68), I have carefully compared with the corresponding teeth of *Portax pictus*, and find that the two are generically indistinguishable, and I therefore come to the conclusion that the fossil teeth probably belong to *Portax namadicus* of Professor Rütimeyer. Similar teeth have been obtained by Mr. Hacket from the Narbada, and by Mr. Fedden from the Pem-ganga.

BOVIDÆ.—Among Mr. Theobald's Siwalik collection, I have lately determined two specimens of the axis vertebræ of a bovine, which, from their large size, must, I think, undoubtedly belong to *Bos acutifrons*. I have compared these vertebræ with a perfect specimen of the axis of *Bos primigenius* in the Indian Museum, and with another specimen figured by Professor Rütimeyer,[1] and I find that although the Indian and European vertebræ are similar in general plan, yet there are many points of detail in which they differ considerably, thus confirming my conclusions drawn from the skulls.

It may be well to mention here that at the time of writing the third fasciculus of this volume,[2] I was unacquainted with the fact that some varieties of *Bos primigenius* have horn-cores with an elliptical cross section at the base, as the specimen drawn in fig. 3 of Plate II of the above-quoted memoir of Professor Rütimeyer. In this respect, therefore, there is a closer relationship between *Bos primigenius* and *B. planifrons* and *B. acutifrons* than I have indicated in the text.

It should also be observed that Professor Boyd Dawkins[3] drops the name *Bos primigenius*, and identifies that animal with the prehistoric and historic *Bos urus*, now represented by the cattle of Chillingham Park. By Professor Rütimeyer, in his last published memoir,[4] the name *Bos primigenius* is retained for the Pleistocene form, and the name *Bos taurus* adopted (as a race name) for the living form.

With regard to the bisons, Professor Rütimeyer has come to the conclusion that the bones of *Bison priscus* are indistinguishable from those of *Bison americanus*, while, on the other hand, *Bison priscus* and *B. europæus* are also indistinguishable specifically.[5] There is thus established an intimate connection between the now widely different European and American bisons. In his latest work, however, Professor Rütimeyer[6] retains the three above mentioned specific names, and places *B. sivalensis* as the earliest representative of the group.

The genus *Bubalus* of other writers is split up by Professor Rütimeyer into two genera,[7] which are termed *Bubalus* and *Buffelus;* the former includes the European Pleistocene *B. antiquus* and the living African *B. caffer* and *B. brachyceros;* the latter includes *B. platyceros* (*sivalensis*), *B. palæindicus*, and *B. pallasii* in the Pleistocene. In the recent period Professor Rütimeyer names the living Indian

[1] Nov. Mem. Soc. Helv., Vol. XIX, Pl. IV, figs. 1, 2.
[2] See page 112.
[3] Quar. Journ. Geol. Soc., Lond., Vol. 22, p. 394.
[4] "Die Rinder der Tertiär-Epoche, etc.," p. 189.
[5] See "Prehistoric Times," 2nd ed., p. 296.
[6], [7] *loc. cit.*

buffaloe, *Buffelus indicus:* this name is, of course, synonymous with the name *Bubalus buffelus* adopted by Gray,[1] and *B. arni,* adopted in this volume, after Jerdon.[2]

Professor Rütimeyer also mentions another, apparently Indian species, under the name of *Buffelus sondaicus.*

The genus *Bibos,* according to Professor Rütimeyer, includes the domestic Indian cattle, *B. indicus,* the Gour, *B. gaurus,* a doubtful species named *B. gavæus,* and *B. sondaicus* (*banting* of Gray and this work). *Bibos frontalis* (the Mithun or Gayal) of Lambert and Hodgson is omitted from the list, unless it be *B. gavæus.* Whether or no the Mithun occurs now in the wild state or not, it appears to me to be a distinct species, though there are some skulls in the Indian Museum which bridge over the gap between this animal and the typical Gour.

Cervus.—A palatal portion of a skull containing teeth similar to those figured on Plate VIII, fig. 3, under the name of *Cervus simplicidens,* seems to confirm the generic identification of those teeth. Of *Cervus triplidens* (figs. 1, 2, Plate VIII) I have not obtained any additional specimens, but I think the generic identification is here also correct. One of the Siwalik deer had flattened and branching antlers much like those of *Cervus duvaucellii,* indicating the high state of evolution of the group in Siwalik times.

The Indian Museum has lately obtained a complete maxilla, containing molars like the one tooth drawn in figs. 7 and 10 of Plate VIII. I had some hesitation, as noticed in the text, in referring the figured tooth to *Cervus,* and I still am not quite sure whether such reference is correct, though I think it very possibly is. The amount of variation in the form of the molars of the *Cervidæ* is so great that it is very difficult to say, in the case of isolated teeth, how far this variability may extend. I have, on account of the possibility of doubt, not included *Cervus latidens* in the list of ruminants given on page 180. I hope eventually to obtain materials which will decisively indicate the genus of the teeth in question.

The lower molars of a *Cervus* drawn in fig. 5 of Plate VIII, which I thought might possibly belong to *C. simplicidens,* I now find, from the character of their enamel, belong, in all probability, to a new species, which I propose, on a subsequent occasion, to call *C. sivalensis.*

Palæomeryx.—A single tooth of a ruminant from the Siwaliks, lately presented to the Indian Museum by the Roorkee (Rúrki) Museum, seems to belong to *Palæomeryx,* and to have been about the size of *P. bojani:* this tooth seems to have come from the lower Siwaliks (Nahans), and a lower molar from probably the same horizon in Sind, not impossibly belongs to the same genus.

Camelopardalis.—A more complete lower jaw of *Camelopardalis sivalensis* than the one of which the molars are drawn in fig. 5 of Plate VII of this volume has lately been acquired by the Indian Museum; the new specimen is

[1] Brit. Mus. Cat.

[2] Mammals of India, p. 370.

rather smaller than the figured one. A large series of molars of this genus have also been obtained which seem to indicate the existence of other Siwalik species.

VISHNUTHERIUM.—Two associated upper molars of a sivatheroid from the Siwaliks of the Punjab, present characters which distinguish them from the molars of *Sivatherium*, *Bramatherium*, and *Hydaspitherium;* from the size, and certain details of the form of these teeth, I have thought it not impossible that they may belong to *Vishnutherium iravadicum*, of which the lower molars are figured in Plate VII, figs. 1 and 2.

HYDASPITHERIUM MEGACEPHALUM.—It is possible that some critic may say that the specific name of this species is a barbarism, and, therefore, should be replaced. The name *megacephalum* is undoubtedly a barbarism, but the termination appears to have gained general acceptation as a convenient adjectival form for scientific names. The Greek substantive Κεφαλή if translated into Latin, should probably be *Cephala*, and the only direct adjectival form is Κεφαλωτός; by naturalists, however, a latinised adjectival termination, *Cephalus,-a-um*, is in common use; *e. g.*, *Plesiosaurus brachycephalus*, *Halcyon leucocephala*, *Ptychozoon homalocephalum*. The term *megacephalum* is used for brevity in place of *megalocephalum*, on the precedent of *Megatherium* for *Megalotherium*.

HELLADOTHERIUM.—M. Gaudry[1] states that *Helladotherium* occurs in India. I am not aware on what grounds this statement rests.

These additional specimens will afford ample material for another memoir, illustrative of Siwalik ruminants and their allies.

TETRACONODON MAGNUM.—Since publishing (p. 79) the description of the imperfect mandible figured on Plate X, I have discovered the two last molars belonging to that specimen, which had previously been mixed up with some other specimens. As the execution of Plate X was very poor, I take the opportunity of re-issuing that plate with one of the newly found teeth in its proper serial position. To the measurements of the molars of the figured specimen given on page 80 must be appended, "length of last molar 1·95 inches, width of ditto 1·3 inches." This tooth shows that Falconer's specimen belonged to the upper jaw.

CONCLUSION.—The above additions and corrections will, I hope, render the contents of this volume correct, as far as my present knowledge goes. European palæontologists will, I hope, pardon many shortcomings and redeterminations in my work, which have been in many cases almost unavoidable. The work of a student in vertebrate palæontology in India is one of peculiar difficulty in many ways. He has first of all the difficulty, common to workers in other countries, of having very frequently exceedingly imperfect and scanty remains from which to determine the affinities of an animal, and is consequently liable to false inferences from this source. *Secondly*, he feels the want of a large collection of the remains of described European species of vertebrates for comparison: it is true the Indian Museum in Calcutta possesses a

[1] "Les Enchainements du Monde Animal, Mammifères Tertiaries," p. 79.

considerable collection of casts and remains of non-Indian fossil vertebrates, but these really comprehend only a few of the better known genera.[1] *Thirdly*, although the library of the Geological Survey is an extensive one, there are wanting a great number of the older works on vertebrate palæontology, many of which are now out of print: in many cases, moreover, works, when ordered from England, arrive in India too late for the purposes of the worker who required them. *Fourthly*, the student in Indian vertebrate palæontology at the present time labours under the great disadvantage of working without the possibility of appealing to other workers in the same branch of study for assistance and advice in cases of doubt and difficulty. There are also wanting in the zoological department of the Indian Museum skulls of many genera of living mammals which are required for an exhaustive comparison of their fossil congeners. *Finally*, in the case of Siwalik fossils, there occurs the additional and special difficulty of taking up the work in the incomplete state it was left at the premature death of Dr. Falconer, and of determining ill-defined, imperfectly described species in Calcutta, without access to the original specimens in London. This last difficulty has been the cause of several errors in the specific determinations which occur in this volume.

On the above grounds, I venture to hope that any want of references or comparisons to European fossils, and consequent possible shortcomings in this work, will be looked upon with a lenient eye by my European and American fellow workers.

In conclusion, it is but fair to mention that although there has devolved upon myself the task of describing the Siwalik fossils in the Indian Museum of Calcutta, yet that the far more onerous task of amassing and bringing together that, perhaps, unrivalled series has devolved upon my colleagues in the Geological Survey, chief among whom are Messrs. W. T. Blanford, F. Fedden, W. Theobald, and A. B. Wynne. By far the largest share of this work has been executed through the indefatigable energy and perseverance of Mr. Theobald, who, through heat and cold, drought and rain, has traversed many a weary mile of the hills and plains of the Punjab to attain his object: to him especially are due the thanks of all interested in the history of the tertiary vertebrates of India.

R. LYDEKKER.

INDIAN MUSEUM,
Calcutta, January 1880.

[1] I have the authority of the Superintendent of the Geological Survey of India to offer named duplicate specimens of described Siwalik fossils in exchange for named specimens of teeth of European or American tertiary mammals.

LIST OF PLATES.

LIST OF ABBREVIATIONS USED, AND WORKS AND MORE IMPORTANT MEMOIRS QUOTED IN THIS VOLUME.

"Abhand. der k. k. Geol. Reich." = "Abhandlungen der k. k. Geologischen Reichsanstalt," *q. v.*
"Abhandlungen der k. k. Geologischen Reichsanstalt," Wien.
"Abhandlungen der Schweizerischen pälantologischen Gesellschaft," Basel.
Adams, A. L. "Dentition and Osteology of Elephas antiquus." Palæont. Soc., 1877.
———— "Dentition and Osteology of Elephas primigenius." Palæont. Soc., 1879.
———— "Maltese Fossil Elephants." Trans. Zool. Soc., Lon., Vol. IX.
"Addenda and Corrigenda to Paper on Tertiary Mammalia," Lydekker, R. G. S. I., Vol. IX, p. 154.
"Amer. Jour. Science and Art" = "American Journal of Science and Art," *q. v.*
"American Journal of Science and Art," New Haven.
"Anatomy of Vertebrates," Owen, London, 1866-68.
"Ancient Ruminant Fauna of Switzerland" = "Die Fauna der Pfahlbauten in der Schweiz," *q. v.*
"Animaux Fossiles et Géologie de l'Attique," Gaudry, Paris, 1862-67.
"Ann. Mag. Nat. Hist." = "Annals and Magazine of Natural History," *q. v.*
"Annals aad Magazine of Natural History," London.
"Arch. du Mus. d'Hist. Nat. de Lyon" = "Archives du Museum d'Histoire Naturelle de Lyon."
"Archives du Museum d'Histoire Naturelle de Lyon," Lyons.
"Asiatic Researches," Calcutta.
Baker and Durand: "Memoir on sub-Himalayan fossils." J. A. S. B., Vol. V, p. 490.
Bettington: "Memoir on certain fossils, more particularly a new Ruminant, found at the Isle of Perim, in the Gulf of Cambay." Jour. Roy. As. Soc., Vol. VIII, p. 340.
Blainville: "Ostéographie des Mammifères," Paris, 1839-64.
Blanford and Medlicott: "Manual of Geology of India," Calcutta, 1879.
Blum. = Blumenbach.
Brandt: "Tentamen Synopseos Rhinocerotidum viventium et fossilium." Mem. de l'Acad. Imp. des. Sci. de St. Pet., Ser. 7, Vol. XXVI, pt. 5.
"British Fossil Mammals" = "History of British Fossil Mammals and Birds," *q. v.*
"British Fossil Mammals and Birds." = "History of British Fossil Mammals and Birds," *q. v.*
"British Museum Catalogue of Ungulates" = "Catalogue of specimens of Mammalia in the British Museum, pt. III, Ungulata," *q. v.*
"Bulletin of the United States Geological and Geographical Survey of the Territories." Washington.
"Bul. U. S. Geol. Geog. Surv." = "Bulletin of the United States Geological and Geographical Survey of the Territories," *q. v.*
"Catalogue of A. S. B." = "Catalogue of the Fossil Remains of Vertebrata in the Museum of the Asiatic Society of Bengal," *q. v.*
"Catalogue of specimens of Mammalia in the British Museum, pt. III, Ungulata," Gray, London, 1852.
"Catalogue of Ruminants" = "Hand-list of the Edentate, Thick-skinned, and Ruminant Mammals in the British Museum," *q. v.*
"Catalogue of the Fossil Remains of Vertebrata in the Museum of the Asiatic Society of Bengal," Falconer and Walker, Calcutta, 1859.
"Catalogue of Ungulata" = "Catalogue of specimens of Mammalia in the British Museum, pt. III, Ungulata," *q. v.*
"Cave Hunting, W. B. Dawkins, London 1874.

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"Comparative Anatomy of Vertebrata" = "Anatomy of Vertebrates," *q. v.*
"Compt. Rend." = "Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences," *q. v.*
"Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences," Paris.
"Contributions to the Extinct Vertebrate Fauna of the Western Territories," Leidy, U. S. Geol. Surv. Rep., Ser. 2, Vol. II.
Cope: "Extinct Vertebrata of New Mexico." United States Geographical Survey west of the 100th Meridian, Vol. IV, pt. 2, Washington, 1877.
—— "On the Extinct Species of Rhinoceridæ of North America, and their Allies." Bul. U. S. Geol. Geog. Surv., Vol. V, p. 227.
Croiz = Croizet.
Cuv. = Cuvier.
Cuvier: "Recherches sur les Ossemens Fossiles," Paris, ed. 1836.
Dawkins, W. B.: "Cave-hunting," London, 1874.
—————— "On the Dentition of *Rhinoceros etruscus* (Falc.):" Q. J. G. S. L., Vol. XXIV, p. 207.
—————— "On the Dentition of *Rhinoceros leptorhinus* (Owen):" Q. J. G. S. L., Vol. XXIII, p. 213.
—————— "On the Dentition of *Rhinoceros megarhinus.*" Nat. Hist. Rev., 1865, p. 399.
—————— "On the Fossil British Oxen." Pt. I. Q. J. G. S. L., Vol. XXII, p. 391.
—————— "On the Molar Series of *Rhinoceros tichorhinus.*" Nat. Hist. Rev., 1863, p. 525.
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"Dentition of *Rhinoceros etruscus,*" Dawkins: Q. J. G. S. L., Vol. XXIV, p. 207.
"Dentition of *Rhinoceros megarhinus,*" Dawkins: Nat. Hist. Rev., 1865, p. 399.
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"Die Fauna der Pfahlbauten in der Schweiz." Rütimeyer. Zürich, 1862. Nov. Mem. Soc. Hel., Vol. XIX.
"Die Rinder der Tertiär Epoche, &c.," Rütimeyer: Abhand. der Schweiz. pal. Gesell., Vols. IV, V, 1877-78.
"Distribution of Animals" = "Geographical distribution of Animals," *q. v.*
"Extinct animals of North America," Flower, London, 1876.
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"Extinct Vertebrata of New Mexico," Cope: U. S. Survey west of 100th Meridian, Vol. IV, pt. II, Washington, 1877.
"Extinct Vertebrate Fauna of the Western Territories" = "Contributions to the extinct vertebrate fauna of the Western Territories," *q. v.*
F. and C. = Falconer and Cautley.
Fal. or Falc. = Falconer.
Falconer and Cautley: "Fauna Antiqua Sivalensis," London, 1846-47.
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"F. A. S." = "Fauna Antiqua Sivalensis," *q. v.*
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Further notice of Siwalik Mammals," Lydekker: R. G. S. I., Vol. XII, p. 33.
Gaud. = Gaudry.
Gaudry: "Animaux Fossiles et Géologie de l'Attique," Paris, 1862-67.
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"Genera of Indian Cattle" = "Illustrations of the Genera of the Bovinæ," *q. v.*

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Lyd. = Lydekker.

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——— "Notes on the Mammalian Faunæ of India and Burma." R. G. S. I., Vol. IX, p. 86.

——— "Notices of new and other Vertebrata from Indian Tertiary and Secondary rocks." R. G. S. I., Vol. X, p. 30.

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"Notices of new and other Vertebrata from Indian Tertiary and Secondary rocks," Lydekker. R. G. S. I., Vol. X, p. 30.
"Notices of Siwalik Mammals," Lydekker. R. G. S. I., Vol. XI, p. 64.
"Nouv. Mem. Soc. Hel."="Nouveaux Mémoires de la Société Helvetique."
"Nouveaux Mémoires de la Société, Helvetique," Zürich.
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"Ostéographie"="Ostéographie des Mammifères," *q.v.*
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——— "Odontography," London, 1840-46.
——— "Palæontology," 2nd ed., Edinburgh, 1861.
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"Palæontology, Manual of"—Nicholson, London and Edinburgh, eds. 1872-79.
"Paléontologie et Zoologie"="Zoologie et Paléontologie Generales," *q.v.*
"Paléontologie Suisse"="Materiaux pour la Paléontologie Suisse," *q.v.*
"Pal. Mem."="Palæontological Memoirs and Notes of the late Hugh Falconer," *q.v.*
Pictet: "Materiaux pour la Paléontologie Suisse," Geneva, 1854-73.
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"Proceedings of Zoological Society of London," London.
"P. Z. S."="Proceedings of Zoological Society of London."
"Quarterly Journal of the Geological Society of London," London.
"Recherches sur les Ossemens Fossiles," Cuvier, Paris, ed. 1836.
"Records"="Records of the Geological Survey of India."
"Rec. Geol. Surv. Ind.=" "Records of the Geological Survey of India."
"Records of the Geological Survey of India," Calcutta.
Royle: "Illustrations of the Botany and other branches of the Natural History of the Himalaya Mountains," London, 1839.

Rüt.=" Rütimeyer.

Rütimeyer: " Die Fauna der Pfahlbauten in der Schweiz." Zürich, 1862. Nov. Mem. Soc. Hel., Vol. XIX.

———" Die Rinder der Tertiär-Epoche, etc." Abhand. der. Schweiz. pal. Gesell., Vols. IV, V.

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CORRIGENDA AND ADDENDA.

Page 4, second line of note, for "1864" read "1865."
„ 5, line 12 from top, for "Davis" read "Davies."
„ 15, „ 23 „ bottom, for "Palœindicus" read "Palæindicus."
„ 22, „ 9 „ top, for "2nd Ser., Vol. III," read "1863."
„ „ „ 4 „ bottom, for "fig. 4" read "fig. 1," and on next page.
„ 23, „ 4 „ top, for "Plate 70, fig. 6," read "Plate LXXIV, fig. 1."
„ 24, „ 12 „ bottom, for "least" read "last."
„ 26, „ 11 „ top, for "figs. 2 and 5" read "fig. 5."
„ 31, „ 13 „ bottom, after the word mandible add "(Plate VI, fig. 4)."
„ 32, „ 10 „ top, for "molar" read "premolar."
„ 36, „ 1 „ „ for "hysodont," read "hypsodont."
„ 40, „ 10 „ bottom, for "conven" read "convex."
„ 41, „ 7 „ „ for "Plate 2" read "Plate 5."
„ 43, „ 7 „ top, for "*sumatranus*" read "*sumatrensis.*"
„ 46, „ 19 „ „ for "fig. 23" read "fig. 26."
„ 49, „ 20 „ „ for "anis" read "axis."
„ 51, „ 17 „ bottom, for "valley" read "valleys."
„ 52, „ 1 „ top, for "molar" read "premolar."
„ 54, „ 1 „ bottom, for "hysodont" read "hypsodont."
„ 55, „ 2 „ top, for "hysodont" read "brachydont."
„ 58, „ 11 „ „ for "as" read "or."
„ „ „ 17 „ bottom, for "became" read "become."
„ 60, „ 8 „ top, for "hysodont" read "hypsodont."
„ 61, after line 11 from top, add "GENUS CAMELUS."
„ 63, line 19 from top, for "*elegans*" read "*naui.*"
„ „ „ 3 „ bottom, for "casps" read "cusps."
„ 65, „ 19 „ top, for "hysodont" read "hypsodont."
„ 69, „ 16 „ „ for "*elephas*" read "*elaphus.*"
„ 70, after line 17 from top, add "DIVISION PERISSODACTYLA" (?)
„ 72, line 3 from top, for "Selonadont" read "Selenodont."
„ „ after line 11 from top, add "Order Proboscidia."
„ 76, above first line from top, add "ORDER UNGULATA, DIVISION ARTIODACTYLA."
„ 77, line 15 from bottom, for "*Acotherium*" read "*Acotherulum.*"
„ 78, „ 8 „ „ for "memoirs" read "memoir."
„ 84, „ 8 „ top, for "Pietet" read "Pictet."
„ „ lines 19 and 31, from top, for "Plate IV" read "Plate VII."
„ 85, line 18 from bottom, for "*Sibursi*" read "*Subursi.*"
„ „ „ 12 „ „ for "*palœndicus*" read "*palæindicus.*"
„ 86, „ 4 „ top, for "*palœndicus*" read "*palæindicus.*"
„ „ „ 7 „ „ for "*helveticas*" read "*helveticus.*"
„ 88, lines 4 & 5 from bottom, for (*Plates G and H*) read (*Plates H and I*).
„ 92. This list of Ruminants will be found amplified on page 180.
„ 93, line 6 from bottom, for "just" read "first."

Page 94, line 20 from top, for "Mammalia" read "Mammalian."
„ 95, „ 14 „ „ transpose "Section Selenodonta" and "Division Artiodactyla."
„ 99, „ 1 „ „ for "vertebrate" read "Vertebrata."
„ 102, „ 9 „ bottom, for "Perim-ganga," read "Pem-ganga."
„ 114, „ 3 „ „ for "the following page" read "page 66."
„ 117, „ 1 „ „ for "those" read "that."
„ 126, „ 1 „ top, for "Mammals of Nepal" read "Genera of Indian Cattle."
„ „ „ 2 „ „ for "*urus*" read "*priscus*."
„ 139, „ 1 „ „ for "Perim-ganga" read "Pem-ganga."
„ 141. The species here described as *Peribos occipitalis*, on page 174 is renamed *Hemibos occipitalis*.
„ 145. The skull here described under the name of *Hemibos triquetriceros*, on page 177 is renamed *Hemibos acuticornis*.
„ 148, line 20 from top, for "fig. 6" read "fig. 2."
„ 150, Of the two skulls described as *Amphibos acuticornis*, one (Plate XXI, fig. 1) is renamed on page 178 *Hemibos acuticornis*, and the other *H. occipitalis*.
„ 157, line 9 from top, after the word "species" add a colon.
„ 161, Note, for "page 44" read "page 438."
„ 167, line 6 from bottom, for "Severtgoff" read "Severtzoff."
„ 173. Above "BUBALUS PLATYCEROS," add "Genus Bubalus."
„ 193, line 11 from top, for "left" read "right."
„ 258, „ 11 „ „ „ "left" read "right."

N. B.—The reader is requested to make the above corrections with pen and ink.

DIRECTIONS TO THE BINDER.

In fasciculus 1 ("Rhinoceros deccanensis") substitute descriptions of Plates I, II III, issued with fifth fasciculus (Proboscidia) for the one sheet in the firs, fasciculus; destroy title page and preliminary notice.

In fasciculus 2 ("Molar Teeth and other Remains of Mammalia"), destroy title page and preface, corrigenda and addenda, and appendix issued subsequently; also the page entitled "Index to plates." For Plate X in that fasciculus substitute the corresponding plate issued with the fifth fasciculus, also the descriptions of Plates IV, V, and VI.

In fasciculus 3 ("Crania of Ruminants"), destroy title page and preface, substitute for the original descriptions of Plates XX to XXIV the new descriptions issued with the fourth fasciculus, and intercalate Plates XXI A and B and XXIII A (issued with the same fasciculus) in their proper serial place; substitute reissue of Plates XXI and XXIV for original ones.

Bind title-page to volume, contents, list of plates, etc., at commencement, and index and all the plates at end of volume.

R. L.

FAUNA

OF THE

INDIAN FLUVIATILE DEPOSITS.

RHINOCEROS DECCANENSIS,

A new Species discovered near Gokak, Belgaum District, by R. B. FOOTE, F.G.S., Geological Survey of India.

In May 1871, while looking for sections in the bed of a small nullah, I came upon some fragments of fossil bones and teeth, and amongst them part of an upper molar of a Rhinoceros. I at once set to tracing out the source whence these bones might have been derived, and, after closely examining the banks of the nullah for a few dozen yards further up its course, found a row of large mammalian teeth exposed at a height of 3 feet above the bed of the nullah and fully 8 feet or more below the top of the bed of black clay which here forms the bank, and which black clay passes up into the typical regur of this neighbourhood. The spot at which this discovery was made lies about $3\frac{1}{2}$ miles east north-east of Gokak (a talook town in the Belgaum District, well-known from the proximity of the great fall of the Gatparba River), and about $\frac{5}{8}$ of a mile south south-east of the little village of Chickdowlee, immediately west of which the small nullah falls into the Gatparba River.

This small nullah* has cut deeply into and through the regur at that spot, and has formed a small cliff on the face of which the row of teeth abovementioned was exposed.

The rain-wash from the upper part of the little cliff had covered up everything, the teeth excepted, but on removing it carefully, I found the teeth belonged to the right ramus of the mandible of a Rhinoceros.

Beneath the rain-wash the black clay, though much broken up by sun-cracks, was hard, and the angular fragments were so closely wedged together that it required a good deal of time and trouble to remove those immediately surrounding the bones without disturbing the latter, which were not only extremely brittle, but also much comminuted *in situ* by the action of sun-cracks.

* The Chickdowlee nullah is a small stream rising in the hills to the north-west of Buneechmurdee, and not as it is represented on the map, the extension of the large nullah flowing past Kelvee, which really falls into the great Mumdapoor nullah close to the village of Maldinee.

Had it been feasible I should very gladly have deferred the extraction of these bones for a day or two to do it more leisurely than was then possible; unfortunately the weather was very unsettled, numerous heavy thunderstorms had taken place within the previous week, and another was gathering at the time. Should a flood come down the nullah the greater part of the bones laid bare would certainly be swept away and lost. Then also the spot being between six and seven miles from my camp, it was impossible to keep watch over the fossil remains thus exposed, while the attention of several field labourers had been attracted by seeing me busily removing the soil with my hands, and they in their curiosity would, in all probability, have utterly ruined this valuable specimen had I left it unguarded. I decided, therefore, to take it at once as being the surest way of getting it as nearly as possible entire.

A few inches below the surface the clay became damp, but was still extremely tenacious, and it required great care and much patient labour to loosen the bones without entirely crushing them.

The position occupied by the head was suggestive of its having been drifted into its present resting-place, the heaviest part, the cranium, being undermost. The head had, however, not been entirely overturned, but originally rested on the right frontal bone and supraorbital ridge. The greater part of the right side of the head had been broken away by flood action undermining the bank. Unfortunately most of the bones thus detached and found loose in the nullah were too fragmentary to be joined together.

The left maxilla and left ramus of the mandible were in perfect apposition when freshly exposed, but the left side of the head had suffered severely prior to its entombment, as the frontal and nasal bones were missing.

The position of the left ramus in apposition to the maxilla offers a strong indication of the head, though much mutilated, not having been entirely deprived of its external covering of flesh at the time it was buried in the black clay.

No indications of any bones but such as belonged to the head were met with *in situ*, though the bank was excavated to some little depth after removing all that remained of the cranium.

Among the bones found loose in the bed of the nullah only one or two fragments appear to belong to the body of the animal, and they are somewhat doubtful.

The bones found imbedded were—

1.—The mandible, nearly perfect.
2.—The left maxilla with jugal and lachrymal bones attached.
3.—The squamosal bone with meatus auditorius and post-tympanic process of the left side.
4.—Part of right frontal bone.
5.—Hyoid bones?
6.—Pterygoid bone (right side?)

Lying loose in the sandy bed of the nullahs were parts of the right maxilla, fragments of teeth, and two or three bones too fragmentary to be determined.

Bones very thickly encrusted with two kinds of kunkur.

When found the bones were largely covered with minutely botryoidal calcareous concretions, forming an extremely hard and dense crust irregularly distributed over the surface, in some places in large and thick patches, at others in small wart-like excrescences. From the brittle condition of the bones these were very difficult to remove without destroying the underlying surface of the bones. Many had to be gently rasped away—an operation requiring much time and patience, because of the hardness of the material.

Besides this botryoidal encrustation the whole surface of nearly every bone was covered by a thinner crust of a more earthy material less hard than the former. The less dense parts of this crust assimilated to common earthy kunkur, but some of the dense parts of it, which showed an arrangement in vermicular masses, though less hard, were extremely tough and fully as difficult to remove as the other form of encrustation. The removal of these crusts was, however, quite essential, as they completely hid and altered the true shape of many parts of the bones. The encrustation was by no means confined to the surface—it had penetrated most of the numerous fissures due to the expansion and contraction of the surrounding clay. These intrusions of kunkur had in many cases, particularly where they affected the teeth, given rise to total deformity of the parts by wedging them asunder, sometimes to the extent of half an inch or more. Part of the surface of many of the teeth has been eaten into, as if by a kanker, by the calcareous crust resting on it, forming small shallow pits on the surface of the enamel.

The degree of alteration the bones have undergone is very various in different parts; especially is this the case with regard to the teeth, in many of which part of the enamel is perfectly preserved, while closely adjacent parts have been greatly changed and have lost all lustre and become quite mealy in texture. Excepting external discoloration from contact with surrounding soil, the bones are but slightly altered from their natural color, though a good deal of calcareous matter became infiltrated in their cancellar tissue. The enamel of the upper molars is rather browner in color than that of the lower ones. The dentine of all the broken teeth is a good deal stained along the minute capillary tubules of a deep black, apparently due to the presence of oxide of manganese. The cavities in the fangs of the teeth left by the decay of the pulp are mostly lined with acicular crystals of arragonite. The dentine was found to be traversed by innumerable minute cracks, rendering the mass extremely brittle, especially near the base of the crowns and in the fangs. Owing to this many of the teeth fell to pieces, and had to be built up by fitting piece to piece—a very long and tedious task from the great number of tiny fragments that had to be dealt with. But for the fact that the manganese stains of the dentine tubules above alluded to often formed patterns on the broken surfaces, the building up process of the dentinous parts would have been simply impossible.

Some change in the form of some of the bones has been caused by the pressure of the mass they were imbedded in. The parts principally affected by such pressure are the mandibles, the jugal arch, and the supradental portion of the left

maxilla. The mandible is materially distorted, the right ramus especially having been forced over to the left side very considerably, and the symphysis having been twisted so that the left side of the symphysial prolongation is fully half an inch higher in level than the right. The right ramus is also rather broken at the lower edge about the middle of its length.

The upper and outer part of the left maxilla above the molar series is much crushed out of shape, so much so that the jugal arch, instead of being parallel to the side of the skull, has been turned over outwards, so that at present it has a position nearly at right angles to its normal one.

The plane of the dental series of the maxilla has also been considerably more curved than normal, the result being that the molars and premolars, instead of being in close apposition to each other as in all other species of Rhinoceros, are divided by spaces. This is especially observable between *premolars* 2 and 3 and *molars* 1 and 2 and 2 and 3. The bones appear to have been in a rather soft state when thus affected, else they must have been far more extensively fractured.

On comparison with all the other described species of Rhinoceros, both living and fossil, the head discovered at Chickdowlee shows such marked differences that it cannot be assigned to any one of them, and deserves, therefore, to be considered as a distinct and hitherto undescribed species. As such I propose to call it *Rh. Deccanensis;* and as the region in which it was found belongs distinctly to the Deccan in the older and fuller meaning of the name, and most of the other Asiatic Rhinoceroses, both recent and fossil, have been distinguished by geographical specific names, the one now proposed appears quite suitable.

The head only of *Rh. Deccanensis* being known, comparisons could only be instituted with corresponding parts of specimens of other species. Eight distinct points of character came specially under comparison, and they were in order of importance—

1.—The proportional height of the crowns of the teeth.
2.—The form of the symphysis of the mandible.
3.—The presence or absence of incisor teeth and their size.
4.—The special structure of the upper molar series.
5.—The form of the bones of the periotic region.
6.—The form and proportions of the zygomatic arch.
7.—The relative size as compared with that of other species.
8.—The deciduous character of premolar 1.

In carrying out the comparison of the remains of this Rhinoceros with those of other species, I have followed the methods adopted by the late Dr. Falconer and by Mr. Boyd Dawkins, F. R. S.,* and for the descriptive portion and plates have adopted the terms (with two exceptions) and indicative letters employed by the latter palæontologist in his several very able papers on the dentition of the Rhinocerotes found fossil in Great Britain.

* See Falconer's Palæontological Memoirs and Mr. Boyd Dawkins' papers in the Natural History Review, 1863 and 1864, and Quarterly Journal of the Geological Society, Vol. XXIII, 1867, and Vol. XXIV, 1868.

With regard to living species I have followed the latest enumeration given by Dr. J. E. Grey in the "Annals and Magazine of Natural History"* in continuation of the list published in his catalogue of the Pachydermata in the British Museum.

Unfortunately some species included among those are founded on external characters only, *e. g.*, *Rh. Oswellii* and *Rh. Crossii,* and with such, of course, comparisons were impossible.

My specimen was compared with all known published descriptions and with the fossil and recent specimens in the British Museum, the Royal College of Surgeons, London, the Jardin des Plantes, Paris, the Museum of the K. K. Geol. Reichs Anstalt, Vienna, the Imperial Museum, Calcutta, the Madras Museum, and last, but not least, the Geological Museum, Calcutta. And here I would express my sincere thanks to Mr. Henry Woodward, F. R. S., to Mr. Davis of the Palæontological Department of the British Museum, and to Professor A. Gaudry of the Jardin des Plantes, for the true courtesy with which they gave me every assistance in their power in carrying out such comparison with the specimens in their custody.

The head of *Rh. Deccanensis* indicates a smaller and slighter animal than *Rh. Indicus,* but one larger in all probability than any of the other living Asiatic species.

Dental formula.

The head is that of a young adult animal whose permanent dentition is represented by the formula $I\frac{0}{0}$? $C\frac{0}{0}$, P. M. $\frac{2\text{-}3\text{-}4}{2\text{-}3\text{-}4}$, M. $\frac{1\text{-}2\text{-}3}{1\text{-}2\text{-}3}$. The teeth, which were not furnished with a cement layer, are not much worn down by use; indeed, the last molars in each jaw had only just begun to show signs of wear. The animal belonged very markedly to the hypsodont section of the family.

The incisors are wanting in the mandible, and from the rather broken condition of the incisive border of the symphysial portion, it is difficult to be quite positive whether alveoli had ever been developed there or not. The incisors, if developed there, were extremely small and quite rudimentary.

The premaxillary bones are unfortunately wanting; hence the presence or absence of incisors in the upper jaw cannot be determined, but the probability is that they were extremely small or wanting. Two fragments of bone were found loose, which present some resemblance to the anterior extremities of pre-maxillary bones in other species, and, if they should really be such, their appearance certainly disfavors the idea that the animal possessed upper incisors.

Professor Owen has pointed out that the development of the horns of the *Rhinocerotes* is in the inverse proportion to the magnitude of the incisors. If this law held good in *Rh. Deccanensis,* it must have had a very large horn or pair of horns.† Unfortunately, however, the nasal bones were not found; so, this point remains for the present undecided.

* Annals and Magazine of Natural History, 4th Series, Vol. XI, p. 356.

† Owen's Comparative Anatomy of Vertebrata, Vol. III, p. 356.

The mandible.

The anterior or symphysial part of the mandible is prolonged beyond the premolars in a narrow beak-like projection unlike in form or proportion to any species hitherto described and figured. A correct idea of its form will be obtained by referring to figures 3 and 4, Plate II. The peculiarity of this symphysial prolongation consists in its narrowness and in the sudden diminution in width in front of the permanent premolars. *Rh. Etruscus,* Falconer, which of fossil species most resembles it, shows a less sudden constriction, if the term may be used, of the extension of the symphysis in front of *premolar* 2, and the extension is moreover wider in proportion. In *Rh. niger,* Gray, the symphysis is narrow, but longer than in the Deccan species, and ends in a sharp toothless incisive border. Many species of Rhinoceros, both recent and fossil, show this extension of the symphysis, but instead of its being narrow throughout its length and constricted immediately in front of the premolars, it is wide at first, then narrows, and before reaching the incisive border spreads out again in a spatulate form. In many species large or moderate sized incisors project from the anterior border. In *Rh. Deccanensis* the rather broken condition of the incisive border (*i. b.* fig. 4, Pl. II) renders it a little doubtful whether incisors had been developed there or not. If the small and irregular cavities observable in that situation were true alveoli, and probably they were so, the incisors must have been very small and rudimentary, as has already been mentioned above. There is no trace of them left, so they had probably been shed while the animal was alive.

The incisors.

There are no indications of large mentary foramina like those so strongly developed in *Rh. Etruscus.*

The ascending portion of the ramus.

As already mentioned (*ante,* p. 5) the symphysis has been somewhat twisted by pressure, and the right ramus has been forced over considerably towards the left one, and the central part of the lower edge rather broken. The left ramus appears to be unaffected by the pressure, but has lost the coronoid process. The condyle is relatively small, the transverse length of the articular surface being only 3 inches, while the same part in an otherwise much smaller mandible of *Rh. Sondaicus** measured $3\frac{1}{2}$ inches across. The curve of the ascending part of the ramus commences just below the median groove of *premolar* 3. The height of the ascending part of the ramus is 9·15 inches to the summit of the condyle, measured vertically from the surface the mandible rested on, or 11·75 inches, measured with a tape along the posterior edge from the condyle to the angle. From the angle to the incisive border, measured along the under side of the ramus, is a distance of 19 inches. The left ramus only was measured, being much the more perfectly preserved. The posterior edge of the ascending ramus rises almost straight, and is not notched below the condyle as in *Rh. Sondaicus* and various other species.

* In the collection of the Imperial Museum, Calcutta.

The lower molar series.

The lower molar series is represented by six normally-shaped tall crowned teeth—three premolars and three molars. Of these premolar 2, on either side, is perfect, except that the posterior wall is rather broken.

Premolar 3 is imperfect on both sides, the inner being broken away. Premolar 4 is altogether wanting in the right ramus and wants the inner wall in the left ramus.

Of the true molars in the right ramus, molar 1 is rather imperfect; molar 2 and molar 3 are perfect in the crowns; these are figured in Plate III, figs. 2 and 3. It will be observed that the posterior collis of premolar 3 had only lately begun to come into wear. The corresponding teeth in the left ramus are less well preserved. The lower molars of *Rh. Deccanensis* are not specialized, and offer no strikingly characteristic differences from many other species. The guard is but slightly developed on the anterior and posterior walls, and does not show on either the inner or outer walls in the lower molars. Molar 1 of the left side has been forced upwards and backwards by an intrusion of the encrusting matter, as shown in fig. 3, Plate II.

The annexed measurements of the lower molars may be interesting for purposes of comparison—they are as exact as the imperfect state of the specimen admitted of their being. They were made in the following directions, after Mr. Boyd Dawkins's system, at the base of the crowns:—

1.—Antero posterior, along outside of crown.
2.—Antero transverse, across anterior collis.
3.—Postero transverse, across posterior collis.

Tooth.	*Side.*	1.	2.	3.
Premolar 2	Right	1″ 3‴	$6\frac{2}{3}$‴	...
Ditto 3	Left	1″ 3‴	...	...
Ditto 4	do.	1″ 7‴	...	...
Molar 1	Right	1″ 8‴	1″$2\frac{1}{2}$‴	1″ 4‴
Ditto 2	do.	1″11″	1″3″	1″ $3\frac{3}{4}$‴
Ditto 3	do.	2″ 1″	1″3‴	1″ $2\frac{2}{3}$‴

The length of either row of lower molars on the right side is $11\frac{1}{8}$ inches, measured along the outer bases of the crowns.

Before passing on to the description of the much more complex upper molar series, it will be better to give a key to the indicative letters used in the plates, and which, as already mentioned, agree with those employed by Mr. Boyd Dawkins in his several memoirs. As both upper and lower molars are recognized to be formed on the same plan, though differing very greatly in the degree to which that plan was developed, the letters apply to the homologous parts in both series. The teeth are compared to a hill sub-divided by two valleys running down from the main ridge or outer wall of the tooth. Besides the subordinate hills thus formed, there are certain processes jutting from the walls of these hills into the area of the valleys, certain prominent ridges on the outer wall, certain remarkable ledges of enamel running round the sides of the walls, and certain grooves dividing the outer wall into areas, which all have to be accounted for, as their form, or presence, or absence are of great and often specific import. The comparison to a hill only

holds good to a certain extent, but it would be very difficult to find any natural object with which a better comparison could be instituted, and it has been adopted in part by so many eminent palæontologists that it is better to carry it on than introduce another, though a much better one might be found if a fortification, such as a small Indian fort or mediæval castle, were the object adopted for the comparison. The following list shows the principal parts of the teeth and the letters they are indicated by :—

*a. Anterior valley.‡
*b. Posterior valley.||
*c. Accessory valley.
*d. Anterior collis.§
*e. Median collis.¶
*f. Posterior collis.
g. Anterior process=crista. } "Combing plates" of Boyd Dawkins.
h_1. Median process. }
h_2. Posterior process=crochet=uncus. }
i. Median groove on outer wall of tooth.
*k. Costæ on the outer wall.
l. Outer wall (divided by "i" into "m" and "n"). "External lamina" of Boyd Dawkins.†
m. Anterior area.
n. Posterior area.
o. Guard=cingulum=bourrelet=wulst.
p. Opening to anterior valley or "pass."

The maxilla and upper molar series.

The left maxilla was found *in situ* with its six teeth, and is figured in Plate I. Of the right maxilla only fragments were found loose in the bed of the nullah, and from these the teeth were missing, but fragments of some teeth were also found loose. The upper molars were unfortunately more affected by decay (whatever may have been the cause), and more penetrated by the veins of encrusting matter, while the great depth of the valleys rendered them more fragile than the lower molars. Of the teeth in the left maxilla *premolar* 2 and *molar* 2 are much broken. *Molar* 1 and *molar* 3 are also considerably damaged: still enough remains to give a fair idea of this most characteristic part of the whole dentition. In both *premolar* 2 and *molar* 2 the outer wall is wanting.

The premolars of *Rh. Deccanensis* are specialized by the very great development of the ledge of enamel, known as the cingulum or guard (Boyd Dawkins), which occurs mostly on the anterior and inner walls of the teeth, and which is well shown in both figs. 1 and 2 of Plate I. I think I am right in saying that in no other species is this peculiar appendage of the premolars so strongly developed, and in this respect it resembles some of the European miocene species. Premolar 1 was deciduous and probably a very small tooth, as no sign of it can be made out on the edge of the maxilla. In premolar 2 a small pit,* fig. 1, Plate I, shows in the enamel ledge or

* The equivalent terms in Latin are employed by Brandt (*Rh. tichorhinus*, Mem., Acad. St. Peter, 6e ser., tom. VII.)

‡ Vallon oblique, in upper molars, Cuvier.

|| Ecorchure aù bord posterieur, Cuvier; Fossette posterieur, Blainville.

§ Colline seconde, of upper molars, Cuvier.

¶ "La troisième colline," of upper molar, "le bord posterieur de la dent." Cuvier.

† Collis externus, Brandt. "Colline première qui suit exactement le bord." Cuvier.

guard on the anterior wall of the tooth; this is the only part of the building up of the teeth that I feel a shade of doubt about, because such a pit does not seem to be known in other species; the fragmentary parts, however, fitted most perfectly together. The corresponding portion of the right jaw premolar, is unfortunately unknown. This tooth is a good deal more worn than premolar 3 and 4, and the pass *p*, leading from the inner wall of the tooth to the anterior valley, is almost obliterated by wear. The edge of posterior wall of the tooth has also been so much worn that the posterior collis is separated from the posterior valley by a belt-like surface of dentine. In premolar 3, on the contrary, much less wear has taken place, and the three colles stand up distinctly. The guard commences on the anterior wall, at about one-third of the length of the wall from the anterior angle of the outer wall, and runs all round the inner wall till it merges in the posterior collis. The pass *p* dividing the anterior and median colles is deep and sharply defined. The external side of the anterior valley (*i. e.*, the side next the exterior wall of the tooth) is rather broken round the top. A spur of enamel projects from the median collis very nearly across the anterior valley, and shows that a very strongly marked crochet characterized this tooth. The posterior valley is rather oval in shape, imperfectly so however, as the curve on the posterior side of the major axis is much greater than that on the anterior side of the axis, which is parallel with the axis of the median collis. The posterior wall of the tooth descends but little from the posterior collis, and thus shows signs of wear, and also gives the posterior valley a decidedly pit-like appearance quite different from the bay-like appearance it presents in many other species, owing to the posterior wall of the tooth being deeply notched by the posterior valley. This character belongs also to the posterior valleys of premolar 2 and 4. The outer wall of premolar 3 is characterized by the anterior angle or costa k_1, forming an acute angle; k_2 the second costa is well developed, but the whole wall of the tooth is remarkable for its flatness.

Premolar 4 is, on the whole, very little different from premolar 3, though of considerably larger size. The chief difference lies in the larger proportional size of the anterior collis, which is taller and more bulging a little below the present surface of mastication. Premolar 4 is perhaps a little less worn down. The anterior angle of premolar 4 is also rather more acute. The appearance of greater height in the anterior collis of premolar 4 as compared with *premolar* 3 is in measure due to the lower position occupied by the guard on the anterior half of the inner wall of the tooth. The central part of the masticatory surface is rather broken, but there is a well marked fold of enamel projecting from the median collis, h_2, showing that a large crochet would be present were the tooth unbroken. The outer wall of the tooth is, like that of premolar 3, remarkable for its flatness, which greatly exceeds that of all other species I have been able to compare it with. This character will be apparent from a comparison of fig. 1 in Plates I and II.

The true molars, as already stated, are unfortunately less well preserved, but enough remains to recognize many of their chief characteristics. The true molars

will be seen not to show the great development of guard which is so conspicuous in the premolars. The guards in both molars is confined to the anterior wall of the tooth, and there it occupies a much smaller space, extending less than half the length of the wall from the inner anterior angle. Moreover, in molar 1 its position is very different, as it lies very high, nearly level indeed with the crown surface of the anterior collis, upon which it rather encroaches and makes a small shelf, harp-shaped in plan, instead of a jutting ledge. In molar 2 the guard forms a wide ledge, sloping upward from the inner anterior angle nearly to the middle of the anterior; unlike *m.* 1, however, the guard springs from a point about half way down the side of the anterior collis. The anterior collis of the true molars is of much larger proportions than in the premolars, as compared with the whole size of the teeth, being very broad and stout, especially in molar 1, where it forms much more than half of the inner side of the tooth. By this increase of size in the anterior collis the anterior valley is greatly narrowed, and the pass no longer occupies a median position, and has become very narrow and much deeper than in the premolars. The crochet h_2, is very large, and all but touches the posterior wall of the anterior collis. The outer wall of the anterior valley also forms a projecting fold of enamel (h_1, fig. 1, Plate I), which projects forward and inward. The posterior valley is unfortunately wanting, that part of the tooth being broken away, but judging from the fragment of *molar* 1 of the right jaw, which was found loose in the nullah-bed, the posterior valley most likely resembled that of premolar 4. This fragment, which is figured in Plate II, fig. 2, shows a saddle-like slope descending from the posterior collis *f* into the posterior valley. On the outer wall of the tooth it will be seen that the anterior angle is less prominent than in premolar 4; the hinder part of the outer wall is much broken, but not too much to show the peculiar flatness described as characteristic of the premolars. The figure of the fragment of molar 1 of the right jaw above referred, was given to show the great depth of the anterior valley, which, as before remarked, is one of the special characters of the dentition of *Rh. Deccanensis.*

Molar 2, the largest of all the series, is unfortunately the least perfect, the anterior collis only remaining in tolerable preservation. The general character of this tooth can, however, be traced in plan. The form of the guard has been referred to already in the description of molar 1. The anterior collis (*d*) differs less from the analogous parts in premolar 3 and 4 than does that of molar 1. It is less massive in form, and does not encroach so much on the anterior valley. The median collis is, on the contrary, actually and proportionately stouter than in molar 1. The pass (*p*) is a shade less narrow, but would appear to have been quite as deep proportionately in the unbroken tooth. The two crochets h_1 and h_2 were, judging by the remaining lower parts (regarding the tooth as in an inverted position,) much stouter than in molar 1, but the angle at which they rise seems to indicate that they projected less into the area of the valley.

The posterior valley is smaller at the same depth than that of premolar 4, and forms a long ellipse in plan; the major axis of the ellipse being nearly parallel to

the line of the outer wall of the tooth, and far from parallel to the axis of the median collis (e). The outer wall is entirely wanting, and so in fact is the masticatory surface of the entire tooth, that of the anterior collis only excepted.

Molar 3, though unhappily also much damaged, is more perfect than molar 2, and exhibits the trihedral form seen in most of the *Rhinocerotes.* It had undergone but little wear at the time when its owner was entombed. This is proved by the great height of the anterior collis.

The guard occurs only on the anterior walls very much below the crown of the collis. As in the other teeth the anterior valley is extremely deep, and was intruded into a very stout and long crochet (h_2), the base of which is seen at some depth. The posterior collis (f) is represented by a little spur-like cusp (shown in figs. 1 and 2, Plate I) low down on the posterior angle of the tooth.

The teeth of both jaws are furnished with long fangs, but they were not exposed sufficiently in any case to observe any peculiarities they may possibly possess.

The thickness of the enamel varies greatly in different parts of the teeth, being thickest in the walls of the median collis and thinnest in the walls of the crochets and in the exterior walls of the anterior valleys. In the lower molars it was thickest in the outer wall, and thinnest in the walls of the anterior collis.

The length of the upper molar series measured along the edge of the crowns from the posterior angle of *molar* 3 to the anterior angle of *premolar* 2 is 10·9 inches. As before mentioned (page 6), the supradental part of the left maxillary bone is much affected by crushing, so much so that when the malar bone is placed in apposition its plane lies almost at a right angle to its normal position. The distortion is greatest above the true molars. On account of this distortion the zygomatic arch has not been figured. It forms a strong broad band connecting the maxilla with the squamosal bone by a rather flat arch. The zygomatic process is unfortunately rather broken at its base, and the connection of the zygoma with the squamosal bone therefore incomplete.

The lachrymal bone shows a well marked post-orbital projection, and the malar bone has a distinct protuberance on its upper edge opposite to the position the post-orbital process would occupy if developed in this genus.

The squamosal bone is figured in Plate III, fig. 1, in order to show the peculiar form of the groove between the post-glenoid and post-tympanic processes in which the meatus auditorius is situated, as the form of this part of the cranium in *Rh. Deccanensis* differs very greatly from many other species, as will be shown further on in enumerating the points of difference between this and other allied species.

The area between the two processes is wide and shallow at its upper part, rather deeper below the opening of the meatus; in plan it is very nearly rhomboidal. The post-glenoid process terminates in a lobe about two-thirds of an inch below its inferior junction with the post-tympanic. The latter process is greatly

thickened and protuberant near its centre. The meatus occupies the lower half of the area above defined, and is large.

The hinder edge of this mass of bone would appear to be part of the supra-occipital, possibly of the ex-occipital also, and if so, it proves that the occiput was protuberant, not concave as in some species.

The other bones found imbedded were part of the right frontal bone, the right pterygoid and two slim bones which lay between the rami of the mandible, and have a resemblance to hyoid bones, but are not sufficiently well preserved to be identified with certainty.

Rh. Deccanensis is distinguished specifically from all the brachydont miocene species, and also from *Rh. Etruscus*, by its strongly marked hypsodont character and by the non-persistency of the first premolar tooth, but it is allied to many of them by the strong development of the guard in the molar series.

It is allied to the African forms of Rhinoceros by the rudimentary character (or possible absence) of the incisors, but separated by the greatly elongated symphysis of the mandibles and the great development of the guard in the premolars.

There remain then the three European pleistocene species—*megarhinus, hemitœchus*, and *tichorhinus*—one hypsodont miocene form from Pikermi in Greece, the pliocene American form *Rh. crassus*, Leidy, and the living and fossil Asiatic species with which to compare it.

Mr. Boyd Dawkins, F. R. S., in his very interesting paper on *Rh. Etruscus*,* when speaking of the division of the *Rhinocerotes* into two classes by the relative heights of the unworn crowns of their teeth, reckons all the known living species to the hypsodont division, as also all the Asiatic fossil species. It appears to me, however, that three of the more recently established living Asiatic species—*Rh. Floweri*, Gray, *Rh. stenocephalus*, Gray, and *Rh.* (*ceratorhinus*) *niger*, Gray—show such low crowned teeth that they approach more closely to the brachydont type, and that the conclusion that this type had ceased must be modified.

Taking the different species to be compared seriatim, we find that the Deccan

Rh. megarhinus.

species differs from *Rh. megarhinus* by the narrowness of the extended symphysis, which is broad and spatulate in the latter; by the great development of the guard, which is slight in *megarhinus;* by the greater development of (k_2) the second costa on the outer wall; by the different form of the posterior valley, and by the absence of the deep notch on the posterior edge of the rami of the mandible immediately below the condyle.

Rh. hemitæchus.

From *Rh. hemitœchus Rh. Deccanensis* differs by the absence of the thick layer of cement found in the molars of the former; also by the different character of the molar series, for in *Rh. hemitœchus* the anterior and median colles are very narrow and compressed, and the posterior collis very low and small. In *Deccanensis*, on the contrary, the

* Quarterly Journal, Geol. Soc., Vol. XXIV, 1868, p. 214.

anterior and median colles are stout and broad, and the posterior collis, though small, attains the same level as the median.

Rh. tichorhinus.

From *Rh. tichorhinus* we must separate *Deccanensis,* because of its not possessing the thick layer of cement on the molars; because of the absence of the accessary valley "c," and because the grinding surfaces of the molars are not flat as in *tichorhinus,* but deeply excavated.

Rh. from Pikermi.

From the hypsodont miocene species from Pikermi, near Athens, described, but not named, by Professor A. Gaudry in his splendid work—"Animaux Fossiles et Geologie de l'Attique"—*Rh. Deccanensis* differs by its greatly smaller size; by the position of the guard, which is much higher up the side of the tooth than it is in the Pikermi species. In the latter the posterior wall of the tooth in *premolar* 3, *molar* 1, and *molar* 2 is deeply notched by the posterior valley, which is not the case in *Rh. Deccanensis.*

Rh. crassus.

The pliocene American species, *Rh. crassus,* Leidy, possesses large incisors in the lower jaw, with a broad spatulate symphysis strongly resembling *Rh. Indicus,* while the upper molar series is characterized by the presence of four valleys (anterior, two median, and posterior). Its specific diversity from *Rh. Deccanensis* is, therefore, abundantly clear.

The rudimentary character (or possible absence) of the incisors at once separates *Rh. Deccanensis* from *Rh. Indicus, Sondaicus, Sumatranus, nasalis,* Gray, and *stenocephalus,* Gray, but there are other distinctions also which will be pointed out separately. If I am right in my conclusion that the brachydont type is not yet extinct, *Rh. Deccanensis* would on that ground alone be separated from the remaining living Asiatic species (of which the bones are known), namely, *Rh. Floweri,* Gray, and *Rh.* (*ceratorhinus*) *niger,* Gray, as also from the fossil species *Rh. Sinensis,* Owen; but there are other distinctions also which require their specific separation.

Rh. Indicus.

Taking each species by itself, it will be seen that *Rh. Deccanensis* differs from *Rh. Indicus* in having only rudimentary (or no) incisors, instead of extremely large ones; also by the greater development of the guard, by the much greater relative depth of the valleys, and the much greater flatness of the outer walls of the upper molars. The rugosities at the angle of the mandible, so conspicuous in *Rh. Indicus,* are hardly at all developed in *Rh. Deccanensis,* which likewise has not the deep notch on the posterior edge of each ramus below the condyle. The broad spatulate extension of the symphysis is quite unlike the narrow beak-like form it assumes in *Rh. Deccanensis.* Then the auditory fossa on the squamosal bone is quite unlike, being broadly rhomboidal in shape in *Deccanensis* and much taller and narrower in *Rh. Indicus.* In size *Rh. Deccanensis* was certainly quite one-fourth less than the average *Rh. Indicns,* if the size of the head offers a sufficient datum to go upon in

making such an estimate. Many other minor but well marked differences might be adduced, but the above seem sufficient.

Rh. Sondaicus.

From *Rh. Sondaicus Rh. Deccanensis* is separated by the character of its incisors, which are very good-sized in the former. In *Sondaicus* the guard is only very moderately developed in the premolars, while the teeth are much less high crowned and show relatively much shallower valleys and very tumid outer walls instead of nearly flat ones like those of *Rh. Deccanensis.*

Rh. Sumatranus.

In *Rh. Sumatranus* we find large strong incisors, a very slight development of the guard in the premolars, and a totally different form of the auditory fossa of the squamosal bone, whereby to distinguish it specifically from the Deccan species. In *Sumatranus,* owing to the very great curvature of the post-glenoid process, the apex of the fossa lies far behind the opening of the meatus auditorius, whereas in *Deccanensis* it is very nearly vertically over it. The posterior edges of the mandible are deeply notched below the condyle in *Sumatranus.* The zygoma also is much stouter, more curved in the vertical plane, and shows a crescent-shaped excavation on its upper edge just behind the post-orbital angle—all characters absent from *Rh. Deccanensis.*

Rh. nasalis.

The difference between *Rh. Deccanensis* and *Rh. nasalis,* Gray, consists in the possession by the latter species of good-sized incisors and a persistent first premolar. In *nasalis* the guard is but very slightly developed, and the rami are very much slighter than in *Deccanensis.*

Rh. Floweri.

In *Rh. Floweri,* Gray, the teeth are decidedly less tall-crowned than in *Rh. Deccanensis.* Premolar 1 is persistent instead of deciduous, and the molar series is characterized by a very prominent development of the second costa (k_2) of the outer wall. The zygoma also is much more arched laterally than in the Deccan species, which was a considerably larger animal than *Rh. Floweri.*

Rh. niger.

A comparison of *Rh. Deccanensis* with *Rh. niger,* Gray, shows that the latter has an extended mandibular symphysis, longer in proportion than that of the former, which terminates in a narrow incisive edge not furnished with teeth and not showing any signs of alveoli. *Rh. Deccanensis* shows several small cavities on the incisive border, supposed to be alveoli, from which the existence of rudimentary (though very likely deciduous) incisors must be inferred. The mandible of *Rh. niger* is much slighter, and the ascent of the ramus does not begin till well behind molar 3, whereas in *Rh. Deccanensis* it commences at the middle of the outer wall of molar 3. The ascending portion of the ramus of *Rh. niger* is also much slighter, and is incurved along the posterior edge below the condyle instead of straight as in *Deccanensis.* The zygoma shows a well marked lunate excavation on its upper edge not found in my new species. The meatus auditorius of *Rh. niger* is narrow and leans slightly forward, and is altogether unlike that of *Rh. Deccanensis.*

It has already been shown that *Rh. Deccanensis* agrees with the fossil Indian Rhinoceroses hitherto described in being hypsodont. It differs, however, in many points which will now be enumerated.

Rh. Sivalensis.

Rh. Sivalensis, Falconer, does not show the guard on the inner side of the upper premolars, which is so marked a feature in *Deccanensis*, and both the anterior and posterior valleys are relatively much shallower. The frontal bones of *Sivalensis* are deeply incurved: in *Rh. Deccanensis* they are flat, or but very triflingly incurved. The zygoma of *Rh. Sivalensis* is not so wide in proportion to its length as that of the Deccan species.

Rh. Perimensis.

In *Rh. Perimensis*, Falconer, the guard is also absent from the upper premolars. The anterior and median colles are much more oblique and much narrower, and the anterior valleys are much shallower and pointed at their anterior extremities, while the posterior form deep notches on the posterior wall—all points of marked difference from *Rh. Deccanensis.* The ascent of the rami of the mandible begins well behind molar 3 in *Rh. Perimensis,* and not at the median groove on the outer wall of that tooth as in *Deccanensis.* *Rh. Perimensis* was a larger animal than *Deccanensis.*

Rh. Palœindicus.

The most striking difference between *Rh. Palœindicus,* Falconer, and *Rh. Deccanensis* lies in the form of the auditory fossa, which in the latter forms a broad, shallow, roughly rhomboidal area, with the meatus opening into the lower half. The meatus itself is somewhat triangular in form. In *Palœindicus* the fossa is triangular and very small, with a circular meatus opening centrically and filling nearly the whole space between the post-glenoid and post-tympanic processes. *Rh. Palœindicus* had also good-sized lower incisors, and the prolonged symphysis, although slightly constricted in front of the premolars, expands further forward and becomes spatulate. The upper premolars did not possess a guard, and the valleys of the whole molar series are much shallower than in *Rh. Deccanensis.* The zygoma is more slender than in *Rh. Deccanensis.*

Rh. platyrhinus.

Rh. platyrhinus, Falconer, differs from *Rh. Deccanensis* in possessing large incisors and a broad spatulate symphysis. The auditory fossa is also much narrower, and the zygoma much narrower and more slender. *Rh. platyrhinus* does not show any ant-orbital wart-like rugosities as does *Rh. Deccanensis.* The anterior and median colles in the molar series in *Rh. platyrhinus* are more oblique, and the walls of the valleys much more complicated by foldings of the enamel.

Rh. Sinensis.

Rh. Sinensis, Owen, is very distinct from *Rh. Deccanensis.* It is much smaller and distinctly brachydont; the upper premolars do not possess a guard; the valleys are very shallow, and the crochet a mere wave in the enamel wall of the median collis. Molar 3 is quadrate, rather than trihedral, in plan, and the enamel walls of all the teeth are relatively very much thicker than in *Deccanensis.*

At least three species of Rhinoceros appear to have been found fossil in Burmah, but have not yet been named and determined: of these one was described and figured by Mr. Clift in the Transactions of the Geological Society, 2nd Series, Vol. II, "but not named:" the other two are represented by specimens in the Geological Museum, Calcutta. *Rh. Deccanensis* differs specifically from all three. Of the animal described by Mr. Clift, two much worn left upper molars are there shown, in both of which the posterior valleys form deep notches in the posterior wall—a character not seen in *Deccanensis.* The crochets also are mere waves in the enamel walls of the median collis. The anterior outer angle of the teeth is less acute and less projecting than in *Deccanensis.* K_2, the second costa on the outer wall, is also less prominent than in my new species.

The second Burmese species is represented by a very large and fine left upper molar,* which must have belonged to a very large animal, and far exceeds the largest tooth of *Rh. Deccanensis* in size. It is less tall crowned; has the guard well developed anteriorly, but faintly only on the inner side. A fan-shaped denticule stands at the mouth of the pass into the relatively much shallower anterior valley, and a furrow in the enamel wall descends from the anterior collis into the valley just within the pass—a feature not met with in *Rh. Deccanensis.* There is only one simple crochet. The posterior area of the outer wall is deeply concave instead of being flat, and the posterior outer angle is much less acute than in the Deccan species.

Two right upper premolars, also in the Geological Museum, Calcutta, derived from an animal considerably smaller than *Rh. Deccanensis,* represent the third Burmese species. They are characterized by the excessive development of the second costa of the outer wall (k_2) in a very median position, and relatively much posterior to the position of the moderate-sized second costa in *Rh. Deccanensis.* Two straight spur-like crochets project into the very deep anterior valleys. The more forward of the two crochets, which corresponds to h_1 in my species (see Plate I, figs. 1 and 2), is the larger, and juts out nearly at right angles to the outer wall of the tooth. The anterior and median colles are narrower and more obliquely placed than those in *Rh. Deccanensis.* It is only on the anterior side of the front tooth that any guard is shown.

Associated remains.

At the same time that I obtained the remains of *Rh. Deccanensis,* I found, lying loose in the bed of the nullah, a fragment of a right maxilla with two teeth (probably *molars* 2 and 3) of a large bovine animal, allied to *Bibos gaurus,* which still lives in the Syhadri range.† The condition of the specimen and character of the encrustation covering it indicated that it came from a position corresponding to that of the Rhinoceros now described. In the following season, 1872, I had an opportunity

* This tooth was presented to the Geological Museum by General Sir Arthur Phayre, K. C. S. I., late Chief Commissioner of Burmah.

† The proper name of the so-called Western Ghâts.

of revisiting the locality for a few hours, and besides collecting a variety of fragments, some belonging apparently to the individual I have described, and others to a smaller but very similar Rhinoceros, I also had the good fortune to find a great part of the skull and many vertebræ of a large bovine whose teeth are identical with those obtained in 1871. As in the case of the Rhinoceros these bones broke up a good deal during and after extraction, and I have not yet had an opportunity of restoring them and determining the species of the animal.

The bovine remains were found in the bed of very dark brown clay underlying the black clay in which the Rhinoceros occurred, and intermediate between these two formations I found two thin beds of clayey grit containing numerous specimens of *Unio* ~~and *Cyrena fluminalis.*~~ These shells have all been identified by my colleague, Mr. W. Theobald, as being of living species: the age of the formation they occur in, and of the overlying bed containing the Rhinoceros, may, therefore, be reasonably regarded as pleistocene. There is no record of the existence of Rhinocerotes so far south in the Peninsula of India, nor, as far as I could ascertain, does any tradition of their existence remain among the people. When the individual in question inhabited that region, the principal geological features were probably but little different from what they are now, but the general surface was doubtless covered with vast forests and morasses. Many features of the present surface indicate that various lakes or jheels existed at intervals along the valley of the Gatparba River, formed by the damming back of the waters by several rocky barriers, which have since been worn or broken through and the lakes consequently drained.

The spot at which *Rh. Deccanensis* and the other bones were found lies well within the area of the uppermost of these supposed lakes, which was drained by the lowering of the rocky barrier, in this case of trap, which crossed the Gatpurba Valley at Tegree (Tegedi) some ten miles north-east of Gokak. The idea that this valley was occupied by a lake in former times had been arrived at quite independently by my friend Mr. A. C. Palles, C. E., from the data he obtained when carrying out a great series of levellings in connection with Government irrigation schemes in the Gatpurba Valley.

The Rhinoceros lived no doubt among the swampy valleys at foot of the Gokak hills, and its remains were drifted into the lake after its death.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

DESCRIPTIONS

OF THE

MOLAR TEETH AND OTHER REMAINS OF MAMMALIA.

By R. LYDEKKER, B.A.,

GEOLOGICAL SURVEY OF INDIA.

The present memoir is the second of a series intended, as far as possible, to complete our knowledge of the Vertebrate Faunæ of the tertiary and post-tertiary strata of India, a work which was left unfinished at the death of Dr. Falconer; since that time many new forms of mammalia have been collected by different members of the Geological Survey, and more especially by Mr. Theobald. The present part chiefly contains descriptions of specimens selected from a very large series of detached molar teeth, now in the collection of the Indian Museum. Many of these belong to new species or genera, or have been hitherto known merely by slight notices or small-sized figures in the "Fauna Antiqua Sivalensis" and the "Palæontological Memoirs" of Dr. Falconer.

The first part of the paper treats of the molar teeth of all the species of fossil Indian *Rhinoceros* at present known, and of which there are a large series in the Indian Museum; the second part describes the molars of other genera, chiefly *Ungulata*, but also comprising *Dinotherium*, *Manis*, and *Amphicyon;* this somewhat heterogeneous mixture of genera can scarcely be avoided in taking up a subject parts of which have already been completed; in this paper I have described species of which in most cases we possess little more than the molar teeth or solitary bones, or species of which the crania have been previously figured, but of which the teeth have never been described.

The next part of the series will contain figures and descriptions of the crania of a large number of new and undescribed *Ruminantia*, while a third part will be devoted to the description of the remains of *Carnivora*, of which order several species were named, but only a few described by Dr. Falconer; at the end of this part I shall add a classified synopsis, with references, of all the extinct Indian Mammalia.

Before proceeding to the description of specimens, a few facts may be noticed as to the distribution of some of the species of mammals treated of in this part. Of the genus *Rhinoceros* we have one new species, *R. iravadicus*, now for the first time described, which is confined to Burma, while *R. platyrhinus*, *R. sivalensis*, and *R. palæindicus* are found throughout the typical Siwaliks to the east of the river Sutlej; to the west of the Sutlej, the new species *R. planidens* seems to replace *R. platyrhinus*, as no remains of the latter species have been brought among a large series of specimens by Mr. Theobald from the latter area, and the former species was not known to Dr. Falconer, whose specimens were chiefly obtained from the country to the east of the Sutlej : *Acerotherium perimense* had a larger range than any other mammal, extending from Perim Island along the Siwaliks to Burma. *Dinotherium* has hitherto been only found in Perim Island, Kach, Sind, and the Punjab. *Tapiroid* animals (*Listriodon* and *Tapirus*) have been found in Sind, the Punjab, Burma, and China (Owen) ; *Amphicyon* has hitherto occurred only in the Punjab district, in strata which are probably somewhat older than the typical Siwaliks, while *Dorcatherium* is found along the whole of the Sub-Himalayan Siwaliks and in Sind. Ruminants of the genera *Cervus* and *Antilope* are much more common in the Tertiaries of the Punjab than elsewhere, while *Elephants*, and more especially *Stegodon*, are there much more rare than in the Siwaliks to the east. The remains of *Hippopotamus* are found very abundantly in the strata on the banks of the Markanda and Jhilam rivers ; far away from the present river-courses, the remains of this genus do not seem so common ; if this be more fully confirmed, it will lend support to Mr. Medlicott's suggestion that the present river-courses existed in Siwalik times.

It will perhaps be said by some that I have formed species on somewhat insufficient material ; to this I must reply that I have been very careful never to name any species except on the evidence of characteristic molar teeth or of very characteristic and unmistakeable bones. From the condition of the fossils of the Siwaliks the occurrence of entire skulls of the larger species, except of the stout skulls of *Elephants* and *Bovines*, is extremely rare in comparison to the vast number of specimens discovered.

In the case of the *Cervidæ*, I cannot find instances of any crania having been found in India, either before or since Falconer's time. We are therefore obliged to depend solely upon the characters of the molar teeth, of which we possess a very large collection in the Indian Museum, for specific determination. As there appears but little chance of ever obtaining a skull of this family from the Siwaliks, these teeth alone are important as giving us an idea of the numerous species of these *Ruminants*

which prevailed in former times; should a skull with teeth be hereafter discovered, there will be no difficulty in assigning it to its respective species. The same remarks apply to other animals, of many of which we only possess single teeth. The following species or genera are now for the first time made known or fully described:—

Listriodon pentapotamiæ, Falc. *sp.*	*Dorcatherium majus, nobis.*
Rhinoceros planidens, nobis.	*Dorcatherium minus, nobis.*
Rhinoceros iravadicus, nobis.	*Vishnutherium iravadicum, nobis.*
Cervus triplidens, nobis.	*Dinotherium pentapotamiæ*, Falc.
Cervus simplicidens, nobis.	*Manis sindiensis, nobis.*
Cervus latidens, nobis.	*Amphicyon palæindicus*, Falc. *et nobis.*

I have here to mention my obligations to Dr. Anderson, the Director of the Zoological Department of the Indian Museum, for his kindness in furnishing me with specimens of the osteology of living mammals for comparison with the fossil forms.

Order: UNGULATA.

Div. PERISSODACTYLA, Genus Rhinoceros.

In the "Fauna Antiqua Sivalensis," the late Dr. Falconer distinguished three well-marked species of *Rhinoceros* the remains of which had been found in the strata of the Sub-Himalayan Siwaliks; these species were respectively named *R. sivalensis*, *R. palæindicus*, and *R. platyrhinus*; all these species were founded upon well-preserved crania. A fourth species, *R. namadicus*, from the Nerbudda, was named in manuscript, but only a few limb bones from this locality are figured in the "Fauna Antiqua Sivalensis." Beyond a short description of the cranium of *R. sivalensis*, given by Messrs. Baker and Durand in the Journal of the Asiatic Society of Bengal for 1836, no description of any of the above has appeared. A fifth species of the allied genus *Acerotherium* was also determined by Dr. Falconer on the evidence of molar teeth obtained from the ossiferous beds of Perim Island in the Gulf of Cambay: the name of *A. perimense* was assigned to this species.

Since Dr. Falconer's death another species—*R. deccanensis*, described by Mr. Foote in the first part of the present volume—has been added to the Indian fossil fauna: this species was probably of Pleistocene age; from Pliocene strata in China, Professor Owen has described molar teeth of another species, *R. sinensis*, allied to *R. sumatrensis*.

With the exception of a figure of an isolated upper molar tooth of *R. platyrhinus*, the teeth of all the species of *Rhinoceros* figured in the "Fauna Antiqua Sivalensis" are drawn on so small a scale, and the specimens themselves are generally so imperfect, that the figures, which have no accompanying description, are almost useless for the specific determination of detached molar teeth.

In endeavouring to refer to their respective species a large series of molar teeth of *Rhinoceros* now in the collection of the Indian Museum, I found the great want of good figures and descriptions of the known fossil species with which new ones might be compared. In the present memoir I have endeavoured to remedy this want by giving figures and descriptions of the molar teeth of these old species, together with those of others which could not be referred to any of them.

For the technical names assigned to the different portions of the molar teeth of *Rhinoceros*, I may refer to Mr. Boyd Dawkins' paper on the molars of *Rhinoceros tichorhinus* (Nat. Hist. Rev., 2nd Ser., Vol. 3, p. 526), where they will be found fully explained. There is also a list of most of these terms given in Mr. Foote's Memoir in the first part of this volume.

In the old Siwalik area it will be found that, including the new species here described and the Perim Island species which has lately been discovered in the Siwaliks by Mr. Theobald, there were five species inhabiting the Sub-Himalayan area, though not perhaps all living in the same spot. The assemblage of such a large number of forms of the same genus in a limited area is, to say the least, very remarkable, and one is led to wonder how or for what purpose so many distinct species were differentiated at the same time. The explanation is probably to be found in the existence of an abundant supply of food suitable for the nourishment of large herbivores, and in the presence of a large area for them to wander over. Herbivores, such as the *Elephants* and *Rhinoceros* of the Siwaliks, were of too large a size to be much molested by the attacks of *Carnivora*, and they were also, as far as we know, free from human persecution. Under such circumstances the species of a genus might increase almost indefinitely in number. It appears to me probable that when in any given area the conditions of life are peculiarly suitable for a genus of animals, in that area one would expect to find a great number of species of that genus; the production of species being, according to my ideas, merely an extension of the production of individuals. In a suitable area, the number of individuals would clearly be large, and some of them would vary, and so would originate a new species. When the physical conditions in the same area became less favourable to the genus, the "*survival of the fittest*" would come into play, and the less hardy or less modifiable forms would die out. In the gravels of the Thames valley three species of *Rhinoceros* lived contemporaneously in the same area,* being, I think, next to those of the Siwaliks, the largest number of species in one area.

Rhinoceros Palæindicus, *Falconer*. Pl. 4, figs. 3 and 4.

Of the upper molar teeth of this species of Siwalik *Rhinoceros*, we have no very complete specimens in the collection of the Indian Museum; I have therefore been obliged to content myself with figuring the imperfect but characteristic

* Boyd Dawkins : Nat. Hist. Rev., 1865, p. 403.

fragment drawn in the accompanying plate, together with a figure of a complete premolar tooth copied from the "Fauna Antiqua Sivalensis" (*plate* 75, *fig.* 4). A fair idea of the general form of the upper molars may be obtained from the small-scale figure of a cranium in the above work (*plate* 70, *fig.* 6). My descriptions are in part taken from other incomplete teeth in the Indian Museum.

The fragment drawn (*fig.* 4) is a portion of the inner half of, probably, the second upper molar of the right side; it exhibits the crochet, median valley, and portions of the adjacent colles, which are the most characteristic portions of the tooth. The entrance into the median valley is seen to be extremely narrow, with a very low pass, and no tubercle. The crochet (projecting into the valley from the right) is large, simple, and slightly recurved at its free extremity. In the present state of the tooth (about half-worn) it almost completely blocks the median valley; were the tooth still more worn down, the valley would be completely blocked and the crown would show three pits or fossettes: one of these would be formed by the posterior valley, and the other two by the divisions of the median valley. At a still later stage of abrasion the crown would show two fossettes only; this would be caused by the disappearance of the shallower portion of the median valley, which is placed on the inner side of the crochet, the outer extremity of the median valley being much deeper than the inner.

The anterior collis (*on the left side of the figure*) forms a nearly symmetrical blunt cone, without any "antecrochet," projecting into the median valley opposite to the crochet. This collis is larger than the median collis (*of which a portion is seen on the right side of the figure*), and the two do not overlap one another at the entrance to the median valley. The anterior face of the tooth is nearly straight, having a narrow cingulum along its internal half; the anterior valley is scarcely defined.

The general outline of the crown is approximately square; the dorsum is almost flat, and parallel to the long axis of the tooth. This is the most characteristic part of the tooth, by which it is at once distinguished from the teeth of *Rhinoceros sivalensis*—the only species which it at all resembles: there is one prominent costa on the dorsum situated about half an inch behind the antero-external angle; the latter angle has another rounded costa, but is not produced into a buttress—another characteristic point. The costa on the dorsum does not extend down to the neck of the tooth; the free edge of the dorsum rises into two very slight prominences,—one at the termination of the costa, and another at an equal distance from the postero-external angle. The posterior valley is large and approximately circular.

The length of the dorsum of an imperfect specimen in the Indian Museum is 1·95 inches; this is the only measurement I can give, owing to the imperfect state of our specimens.

The premolar of the same species (*plate* 4, *fig.* 3) belongs to the right side: the general characters of the tooth are the same as those of the molar, *viz.*, the narrow median valley, the large anterior collis (*on the right of the figure*) bending

towards the smaller posterior collis (*on the left*). The crochet is long, pointed, and simple: there is no antecrochet or combing-plate. The posterior valley forms a long narrow slit, cutting into the left side of the figure. There is a small infold of enamel on the anterior side of the first collis; there appears to be no cingulum on the anterior surface.

The peculiar straight dorsum occurs, as in the molars; but this is distinguished in the premolars by the absence of any distinct costa, and by the antero-external angle being sharper. The dimensions of the premolar are—

	In.
External side	2·5
Internal side	1·8
Anterior side	2·6
Posterior side	2·3

The molars of this species may be shortly distinguished by the following points :—

"Narrow median valley; simple crochet; straight dorsum; absence of combing-plate, of buttress at external angle, of antecrochet, and of tubercle at entrance of median valley; three fossettes on worn-crown."

The persistent dentition of this species seems to be less complete than that of any other species of *Rhinoceros*. In the young skull figured in the "Fauna Antiqua Sivalensis" (*plate* 74, *fig.* 1) the last molar has not pierced the gum, and only two premolars are present: the first of these is a small, imperfect, triangular tooth, and does not seem to have had any tooth in advance of it, which view is borne out by the narrowness and smallness of the alveolar border of the maxilla in front of this tooth. If still younger specimens are procured, it would be interesting to make a section of the maxilla to see if there are any rudiments of the anterior premolars "in alveolo." For the present the persistent dental formula must be written as follows:—

$$\text{I.}\ \frac{0-0}{1-1}\quad \text{C.}\ \frac{0-0}{0-0}\quad \text{P.}\ \frac{2-2}{3-3}\quad \text{M.}\ \frac{3-3}{3-3}$$

The penultimate upper premolar, as before said, is a small and irregularly triangular tooth with a smooth dorsum; the least premolar is a much larger tooth, with a straight dorsum having a single median costa opposite the median valley; the true molars have all two costæ on the dorsum. The dimensions of the molars in the above-mentioned cranium are as follows:—

	In.
Length of penultimate premolar	1·10
Length of last ditto	1·65
Length of first molar	1·90
Length of second ditto	2·20
Width of penultimate premolar	0·89
Width of last ditto	1·50
Width of first molar	1·85
Width of second ditto	1·90

The upper molars of this species somewhat resemble those of the European *R. leptorhinus*, Cuv. (*R. megarhinus*, Christol.), in having the dorsum nearly straight and without a buttress at the antero-external angle. The molars of the Indian species are, however, at once distinguished by having three fossettes on the worn-crown, whereas those of the European species have only two; further, the two colles are more equal-sized in the former, and the median valley is much narrower at the entrance than in the latter. The molars of *R. leptorhinus* are further distinguished by a small combing-plate. *R. hemitœchus*, Falc., also has its upper molars with a straight dorsum; and the two colles are in close opposition, as in *R. palæindicus:* the teeth of the former are, however, sufficiently distinguished by never showing more than the two fossettes on the worn-crown, and by having a small combing-plate.

From the molars of *R. sumatrensis* and *R. javanicus* those of the present species are distinguished by having three fossettes on the crown-surface instead of only two.

The upper molars both of this species and of *R. indicus* present three fossettes on the worn-crown, but the fossettes are formed in a different manner: in the present species the two fossettes in the median valley are formed by the valley being divided by the crochet; in *R. indicus* the two fossettes are formed by the union of the crochet and the combing-plate; the molars of *R. palæindicus* have no combing-plate. The same remarks apply to the molars of *R. tichorhinus*, (Cuv.), which are formed on the same plan as those of *R. indicus.*

A figure of the lower molars of this species will be found in the "Fauna Antiqua Sivalensis" (*plate* 75, *fig.* 2); they are characterised by having the posterior valley considerably larger and deeper than the anterior valley, so that the latter becomes completely obliterated at an early period of wear. The median collis is the larger of the three, and the limited dentine surfaces of this and the anterior collis form a complete semicircle.

The lower molar figured in the accompanying plate (*plate* 6, *fig.* 8) seems to belong to this species; it was brought by Mr. Fedden from the Manchhar (Siwalik) beds of Sind. The tooth is from the left ramus of the mandible, and is about one-third worn down. The posterior collis (*left of figure*) is small, and has its dentine surface placed obliquely to the long axis of the crown; the inner extremity of this collis is rounded and narrow; the posterior valley is of considerable depth and size with a wide open entrance; it would not be obliterated until the crown became worn down almost to its base. The median collis (*centre of figure*) forms by far the greater part of the worn-crown surface; its inner wall is flat and vertical, and angulated next the posterior valley; the anterior boundary of the posterior valley forms a wall of enamel running nearly at an angle of 45° to the long axis of the tooth; on the outer side there is a marked angulation in the enamel wall of the anterior moiety of this tooth; the anterior collis (*right of figure*) is very small, though it extends to the inner border of the tooth; the anterior valley is very small and shallow, and

would be soon obliterated. The whole inner border of the tooth forms a nearly straight line; the dorsum has a single vertical groove; there is no cingulum on any part of the crown; the enamel has a nearly uniform thickness. The length of the specimen is 2·2 inches and its greatest breadth 1·1 inches.

This tooth differs from Falconer's figure by the inner wall of the median collis being longer and flatter, and by the obliquity of the median enamel wall to the long axis of the crown. The tooth is, however, nearer to those of this species than to those of any other.

The mandible of this species is spatulate and provided with one large broad incisor on each side.

RHINOCEROS SIVALENSIS, *Falconer*. Plate 4, figs. 2 & 8; and Plate 5, figs. 2 & 5.

Of this species I have figured a very splendid specimen of the upper second molar of the left side, collected by Mr. Theobald in the Siwaliks of the Potwar district. Figures of penultimate and ultimate molars of the right maxilla are given in Messrs. Durand and Baker's paper, noticed above; these figures have been copied in De Blainville's "Osteographie" (*Vol. III, plate* 4). I have again copied the figure of the penultimate molar, as it presents slight differences from our specimen. I have also figured (*plate* 4, *fig.* 2) the ultimate molar of the right side taken from a cranium in the Indian Museum, collected by Mr. Theobald; this tooth, though considerably worn down, still shows the general relations of its component parts.

Taking first the specimen from the Potwar (*fig.* 5), we find the general shape of the crown is approximately square, with a protrusion at the antero-external angle. The anterior collis (*left side of figure*) is considerably the larger of the two; it is a blunt cone in form; the worn dentine surface of this collis runs obliquely towards the antero-external angle of the crown; there is a vertical hollow on the anterior surface of the collis. The median valley (*centre of figure*) runs in approximately the same direction as the dentine surface of the anterior collis; it becomes deeper as it passes, outwards and terminates in a triangular-shaped cavity, which extends deep down into the crown. The median valley is entered by an exceedingly narrow pass, with a sudden fall on either side; there is no tubercle at the entrance to this valley, the bottom of which forms a mere line between the colles. A single pointed crochet extends three-fourths across the valley from the median collis. There is no combing-plate or antecrochet in the median valley.

The median collis (*right side of figure*) forms a slender cone slightly twisted on itself; a small but distinct third or posterior collis is seen on the right side of the former separated by a shallow cleft; this posterior collis is continued outwards, as a narrow wall, becoming lower as it passes outwards, which forms the boundary to the posterior valley (*middle of right side of figure*); this valley is ovate at the top, becoming circular at the base.

On the anterior side of the tooth (*left of figure*) a cingulum runs along the greater part of the surface; the cingulum is broadest on the inner half of the anterior surface, and forms a distinct but shallow, and triangular anterior valley; there is a gap in the cingulum at the middle of this valley: there is no cingulum along the inner surface of the tooth. The antero-external angle of the crown is produced into a very prominent process, the worn surface presenting the section of two arches separated by a valley, and with another valley on the inner side of the most anterior of the two arches; the postero-external angle forms an acute spur.

The dorsum of the tooth is placed obliquely to the long axis of the crown; its upper half curves over towards the inner side; posteriorly to the buttress there is no distinct costa on the dorsum. The worn-crown presents two fossettes only.

The characteristic points of the teeth of this species are as follows :—

" Buttress at antero-external angle: single crochet; curved dorsum and narrow median valley; absence of combing-plate, of antecrochet, and of tubercle at entrance to median valley; two fossettes on worn-crown."

The measurements of this specimen are as follows :—

		In.
Length of	anterior surface	2·4
Ditto	external surface	2·55
Ditto	internal surface	1·85
Ditto	posterior surface	1·95

The presence of the buttress, of only two fossettes on the crown, and the curved line of the dorsum, at once distinguish the molars of this species from those of the preceding species.

The molar tooth figured by Baker and Durand is remarkable for the unequal development of the two colles, the anterior collis being placed much nearer to the inner border of the crown than the median collis.

The ultimate upper molar drawn in plate 4 (*fig.* 2) is from the right side; it shows an anterior collis of large size; the median valley is narrow at the entrance, expands and becomes deeper as it passes outwards; the crochet is very small and blunt, the median collis (*on the left of the figure*) is placed obliquely to the anterior wall (*right of figure*) and is confluent with the outer dentine mass, as in all ultimate molars. In one of Messrs. Baker and Durand's figures of an ultimate molar of this species the crochet is divided at the extremity.

In both this and the preceding species there are no combing-plates present in the median valley, by which the molar teeth are at once distinguished from those of the two next species. The presence of only two fossettes on the worn-crown distinguishes the upper molars of *R. sivalensis* from those of *R. platyrhinus*, in which there are three. The molars of this species have some resemblance to those of *R. javanicus;* the buttress at the antero-external angle is, however, more produced in the fossil species, and the dorsum in consequence is more curved: the cingulum is also larger on the anterior surface in the fossil species: the crochet is

much larger and more pointed in the Siwalik form than in the living species; the molars of both species agree in having only two fossettes on the worn-crown. The molars of *R. sivalensis* are distinguished from those of *R. tichorhinus* (Cuv.), and of *R. indicus* by the presence of only two in place of three fossettes on the worn-crown and by the absence of the combing-plate. They resemble those of *R. sumatrensis* in having a large buttress at the antero-external angle; the median collis is, however, much smaller in proportion to the anterior collis in the fossil than in the living species, and the latter lacks the large cingulum which occurs on the anterior surface of the teeth of the former species.

From the molars of *R. leptorhinus* and *R. hemitæchus* the very prominent buttress at the antero-external angle, the absence of the combing-plate, and the curved dorsum of the molars of the present species are sufficient distinctions.

The molars of *R. etruscus* (" Fal.: *Pal. Mem., Vol. II, plate* 25, *fig.* 7) somewhat resemble those of *R. sivalensis,* both having a buttress at the antero-external angle, a long cingulum on the anterior surface, unequal colles, a simple pointed crochet, no combing-plate, and presenting only two fossettes on the worn-crown surface. The molars of *R. sivalensis* are, however, distinguished by the posterior collis being more distinct and elongated, by the inner extremity of the median valley being three-cornered instead of oblong, by the crown being relatively longer in proportion to its width, and by the ridges of the buttress being placed farther apart, and extending lower down on the surface of the crown.

The persistent dentition of this species seems to be as follows :—

$$\text{I.}\frac{0\,(?)-0\,(?)}{0-0}\ \text{C.}\frac{0-0}{0-0}\ \text{P.}\frac{4-4}{3-3}\ \text{M.}\frac{3-3}{3-3}$$

Figures of very much worn lower molars of this species are given in plate 75 of the " Fauna Antiqua Sivalensis." The specimen figured here (*plate* 6, *fig.* 1) is the last molar of the left ramus of the mandible; the crown is in an early state of wear. Ths anterior collis (*extreme left of figure*) is remarkable for its very small size; its inner boundary not extending beyond the middle line of the crown; the anterior valley (*left of figure*) is narrower and shallower than the posterior valley (*right of figure*), and extends farther on the outer side; the worn dentine-surface of the median collis (*centre of figure*) runs nearly at right angles to the antero-posterior axis of the tooth, while that of the posterior collis is placed very obliquely to the same axis. The posterior surface of the tooth is divided by a deep and nearly vertical groove; on the inner side of this groove there is a very small conical tubercle; there is no cingulum on any part of the tooth; the enamel is smooth and polished and of uniform thickness. Owing to its shallowness the anterior valley becomes obliterated at an earlier period of wear than the posterior valley. The length of the specimen is 2·4 inches, and its width 1·4 inches.

From Falconer's figure the species seems never to have developed the first premolar in the lower jaw; the second premolar is of relatively large size. The

mandible is but little produced in front of this tooth, and seems to have been unprovided with incisors.

RHINOCEROS PLATYRHINUS, *Falconer*. Plate 4, fig. 4.

The subjoined description of the upper molars of this species is partly derived from the restored figure of a penultimate upper molar of the right side given in the "Fauna Antiqua Sivalensis" (*plate* 76, *fig*. 11 *a*) : [*this figure is copied in the present paper (plate* 4, *fig*. 4,) *on a scale of one-half the natural size ;*] and partly from a cast of the molars of the complete cranium of the species discovered by Colonel Baker, and now in the British Museum. The species is confined to the Siwaliks.

The specimen in the accompanying figure is the above-mentioned penultimate right upper molar; the transverse diameter of the anterior collis (*on the right of the figure*) considerably exceeds that of the median collis (*on the left*) *;* the base of the median collis overlaps that of the anterior collis, so that, in the position of the figure, no part of the base of the median valley externally to the crochet is visible from the front. The anterior collis forms a thick depressed cone, projecting on the posterior side into the median valley. The median collis is unsymmetrically shaped, the posterior wall being nearly vertical, while the anterior boundary forms an irregular convex line, blocking the entrance to the median valley. The pass to this valley is sharp and well marked, somewhat external to the inner boundary of the tooth, and as high as the level of the cingulum, with an abrupt descent into the valley. There is no tubercle obstructing the entrance to the median valley, which winds between the bases of the two colles as a narrow sinuous line.

The crochet is given off from the side of the median collis nearly at right angles to the inner border of the tooth, and has a loop of enamel on its external side; in the angle formed between the internal wall of the crochet and the anterior wall of the median collis there is a small fold of enamel; the base of the crochet is but slightly constricted; the anterior wall of the crochet slopes towards the inner side of the tooth, so that the bottom of the valley is very narrow at this point; the whole of the bottom of the valley, from the entrance as far as the crochet, forms, therefore, a mere line between the colles.

Externally to the crochet the median valley is divided into two parts by the combing-plate (*seen at the top of the median valley*), which is small and blunt, and forms an angle of 45° with the internal border of the tooth; there is no antecrochet given off from the anterior collis; the anterior boundary of the median valley forms a line running at right angles to the inner border of the tooth, and there is consequently no production of the valley in the direction of the antero-external angle of the tooth.

The dorsum of the tooth is marked by a slight anterior costa; the antero-external angle forms a sharp edge, but is not produced into a buttress; the postero-

external angle is produced backwards. A distinct cingulum runs along the whole of the anterior surface and that surface only.

The anterior valley is very narrow, bounded by the straight anterior portion of the cingulum; the posterior valley (*on the left side of the figure*) is very small and narrow; the median collis in the specimen is worn down and united with the small posterior collis.

Were the crown to be more worn down than in the figured specimen, the combing-plate and the crochet would unite and form a second fossette in the median valley, so that the crown would present three fossettes, two formed by the median valley and the third by the posterior valley.

The dorsa of the molars can be best studied from Colonel Baker's cranium: in the premolars there are two vertical ridges placed opposite the two large colles; in the first molar the hindmost of these ridges is much smaller than the other; in the second molar it has nearly, and in the last molar quite disappeared. The outer border of the crown in all the teeth is nearly parallel to the long axis of the tooth, and wears quite flat. The colles in the premolars are more equal sized and the pass into the median valley is higher in the premolars than in the molars. The following are the dimensions of the molar series in Colonel Baker's cranium:—

	In.
Length of six molars	13·0
Do. of outer surface of last molar	2·75
Do. do. do. of penultimate molar ...	2·70
Do. do. do. of first do. ...	2·40
Do. do. do. of last premolar ...	2·10
Do. do. do. of penultimate do. ...	2·05
Do. do. do. of first do. ...	1·75
Width of penultimate molar	3·00
Width of first premolar	2·22

The dimensions of the figured upper molar of this species, as given by Dr. Falconer, are as follows:—

	In.
External side	4·0
Internal side	2·7
Anterior side	3·0
Posterior side	2·5

A smaller specimen, also figured in the "Fauna Antiqua Sivalensis" (*plate* 72, *fig.* 6), has the following measurements:—

	In.
External side	3·6
Internal side	2·2
Anterior side	2·9
Posterior side	3·0
Height of crown	3·1

The persistent dentition of this species is as follows:—

$$I.\ \frac{0-0}{2-2}\ C.\ \frac{0-0}{0-0}\ P.\ \frac{4-4}{3-3}\ M.\ \frac{3-3}{3-3}$$

The median lower incisors were very small and functionless; the first upper premolar was shed before the last molar pierced the gum. Falconer compared the upper molars of this species to those of *Rhinoceros tichorhinus* of Cuvier: the molars of the two species agree in presenting three fossettes on the crown-surface; but the molars of the European species are distinguished by the greater size of the posterior valley, by the non-prolongation of the postero-external angle of the crown, by the combing-plate being placed nearly at right angles to the external border, by the absence of the cingulum on the anterior surface, and by the dentine-surface of the anterior collis being curved instead of straight. The presence of three fossettes on the worn-crown sufficiently distinguishes the upper molars of *Rhinoceros platyrhinus* from those of *R. hemitæchus, R. leptorhinus,* and *R. etruscus* of Falconer.

From the molars of both the preceding Siwalik species, the presence of the combing-plates in the molars of this species is a sufficient distinction.

The upper molars of *R. platyrhinus* agree with those of the living *R. indicus* by having a combing-plate and three fossettes on the worn crown-surface; those of the latter species are, however, distinguished by the non-development of the postero-external angle, and by the curvature of the dentine surface of the anterior collis, together with the absence of the cingulum on the anterior surface. Irrespective of the upper molars the two species are at once distinguished by *R. indicus* having but one nasal horn, while *R. platyrhinus* had two; both species agree in having a somewhat spatulate mandible provided with large outer incisors.

The upper molars of *R. sumatrensis* and *R. javanicus* are distinguished from those of the present species by having only two fossettes on the worn-crown, and by the absence of a combing-plate.

To show the form of the lower molars of this species I have figured a detached premolar of the right ramus of the mandible. The specimen is but little worn down, and corresponds in size with the last premolar of the mandible of this species figured in the "Fauna Antiqua Sivalensis" (*plate* 75, *fig.* 10). The anterior collis (*extreme left of figure*) is very narrow, and extends as far inwards as the other two. The anterior valley (*left of figure*) is noticeable for its very small size and narrowness; the posterior valley, on the other hand, is very large and deep; the anterior valley would be therefore obliterated at an early stage of wear, while the posterior would remain for a much longer period. The difference in the times of disappearance of the two valleys is greater than in the lower molars of *R. sivalensis*. The worn dentine-surface of the posterior collis (*right of figure*) is placed at right angles to the long axis of the crown; the dentine-surfaces of the other two colles are also nearly at right angles to the same axis. There is a distinct cingulum running upwards and backwards from the entrance of the posterior valley along the

inner surface of the posterior collis. The enamel is very thin on the anterior collis; over the whole of the tooth it is minutely reticulated. The length of the specimen is 1·6 inches, and its width 1 inch.

A last lower molar of this species in the collection of the Indian Museum has the following dimensions:—

	In.
Extreme length	2·95
Width	1·55
Height of crown	1·42

The form of this tooth is precisely similar to the figured specimen.

The first lower molar of this species is never shown: the second is very small and conical; the mandible is produced into a somewhat spatulate-formed symphysis, and was furnished with a pair of large triangular outer incisors, and a small central pair of round functionless ones.

RHINOCEROS NAMADICUS, *Falconer*. Plate 4, figs. 5 and 6.

Falconer assigned the above specific name to certain limb-bones of a species of *Rhinoceros* from the Nerbudda valley, but I believe no teeth had at that time been obtained. I am not aware whether these limb-bones had ever been compared with those of the other species of the genus. The upper molar teeth in the Indian Museum from the Nerbudda valley closely resemble in form those of the Siwalik *R. platyrhinus*, though they are of much smaller size; and it is only after considerable hesitation that I have separated the two species; my conclusions are partly drawn from certain differences in the teeth, partly from Falconer's separation of the two species, and partly from the fact that almost all the Nerbudda Mammals are distinct from those of the Siwaliks.

The first specimen that I have to describe is an upper molar of the right side (*plate* 4, *fig.* 6); the specimen is probably the second of the series; it is considerably smaller than the corresponding tooth of the last species. The fangs of the specimen are embedded in a hard matrix; the crown is about one-third worn down; the whole of the anterior half and the inner side are complete, but the postero-external angle is wanting.

The transverse diameter of the anterior collis (*right of figure*) is slightly greater than that of the median collis; the base of the latter does not overlap that of the former, so that the entrance to the median valley is nearly at right angles to the inner border of the crown, and is but slightly curved; when the tooth is placed in the position of the figure, the whole of the bottom of the median valley is seen from the front. The anterior collis is of a regular conical form, the median collis is concave on the anterior side; there is scarcely any distinct pass leading into the median valley, the bottom of which is of uniform depth up to the crochet; conse-

quently the entrance to the valley is remarkably low, almost on a level with the base of the crown, and below that of the cingulum; there is no tubercle at the entrance; the basis of the two colles are in contact along the bottom of the valley.

At a distance of one inch from the internal border of the crown the median collis gives off a very large and thickened crochet, which is directed forwards and a little inwards; the neck of the crochet is constricted, and there is no process of enamel in the angle formed between the internal wall of the crochet and the anterior wall of the median collis; the crochet thickens slightly in the middle, and again contracts towards its free extremity; at a level a little below that of the present surface of the crown, the crochet extends completely across the median valley; there is no loop of enamel on its external wall; the moiety of the median valley situated on the inner side of the crochet forms a triangle with curvilinear boundaries, the whole of which is visible from the inner side of the tooth. Externally to the crochet the valley is trefoil-shaped; the leaves of the trefoil are divided by two processes,—firstly, a small wedge-shaped combing-plate, projecting into the valley from the outer side of the tooth; and, secondly, a similarly shaped antecrochet from the anterior collis. The direction of the combing-plate is exactly at right angles to the internal border of the crown of the tooth: when worn down the surface of the crown would display four fossettes,—one formed by the posterior valley; a second consisting of that portion of the median valley which is internal to the crochet. This fossette would not be completely isolated until the tooth becomes worn down almost to the base of the crown, owing to the low level of the entrance to the median valley; the two other fossettes would be on the outer side of the crochet, divided from each other by the combing-plate; they would be isolated at an early period of wear.

The dentine-surface of the anterior collis is directed at an angle of 45° to the internal border of the crown, so that the outer extremity of the median valley is produced towards the antero-external angle of the tooth.

The anterior side of the tooth (*on the right of the figure*) has an undulating outline, prominent in the centre; a wavy cingulum runs along the whole length of this surface; on the internal half of this side the cingulum diverges from the main wall, and forms a well-marked triangular "anterior valley," extending up to the antero-internal angle of the anterior collis. There is no trace of any cingulum along the internal surface.

The posterior valley (*on the extreme left of the figure*) is of very large size, and has a regular oval shape; the longer axis of the oval is nearly parallel with the antero-posterior axis of the crown; the external wall of this valley is nearly vertical, while the internal wall slopes rapidly away towards the median collis; the pass into this valley is sharply defined, forming a ridge descending from the summit of the median collis; the pass leading into the posterior valley is considerable above the level of that leading into the anterior valley, and above that of the cingulum, so that this valley would be isolated at a very early period of wear.

The antero-external angle of the tooth forms a small, sharp, wedge-shaped process; there is one prominent costa on the dorsum of the tooth near this angle; it is not continued upwards as far as the neck. Unfortunately the postero-external angle of the tooth is broken away, so that it is impossible to determine the form of this portion of the crown: from an examination of the base of the crown, where it is buried in the matrix, I consider that the whole of the outer side of the tooth was nearly parallel to the inner side; and that the antero-posterior angle was not produced. The dimensions of this specimen are—

	In.
External side	2·0
Internal side	1·3
Anterior side	2·0
Posterior side	1·5

The molars of both *Rhinoceros platyrhinus* and *R. namadicus* are distinguished from those of *R. sivalensis* and *R. palæindicus* by the complex form of the crochet, and by the presence of a combing-plate. The points by which the molars of the present species are distinguished from those of *R. platyrhinus* are the following:—

Difference in form of the median valley and the base of the two colles.
Presence of an antecrochet.
Difference in size of combing-plates.
Greater size of anterior valley and cingulum.
Relations of posterior valley to median collis, and its relative size.
Smaller size.

The other specimen figured (*plate* 4, *fig*. 5) is the entire and perfect germ of a third or ultimate molar of the left maxilla from the Nerbudda valley; the specimen is in the Indian Museum. I refer the specimen to the same species as the preceding. The figure is taken from the postero-internal aspect of the specimen, looking directly into the median valley; the anterior collis occupying the left side of the valley and the median collis the right.

The anterior collis forms by far the greater extent of the base of the tooth; its transverse section has the form of an isosceles triangle; the summit is bent over towards the inner side; on the anterior side the cingulum commences on the external edge, and forms a V-shaped line along this side of the tooth, running as far as the base of the anterior collis; close to the anterior collis there is a narrow anterior valley of triangular form (*seen on the extreme left of the figure*); the lowest point of the cingulum is rather more than half an inch above the neck of the crown. The median valley is entered by a low pass, without any tubercle at the entrance; this valley becomes deeper as it passes outwards; the level of the pass is the same as that of the cingulum; the entrance of the valley is wedge-shaped. The crochet (*the first projection across the valley*) is of great size and extends com-

pletely across the valley; the combing-plate (*the second projection, on the same side as the last*) is shorter than in the last specimen; it is opposed by the large antecrochet (*the projection from the opposite side to the two former ones*) from the anterior collis; the difference in the relative position of these processes of the median valley from those of the last specimen is caused by the different relations of the boundary walls of the two teeth. Were the crown of this specimen worn down it would present three fossettes in the median valley, one on either side of the crochet, and a third, formed at the outer extremity of the valley, by the combing-plate and the antecrochet. The posterior valley, as in all ultimate molars, is not present, and the median collis becomes confluent with the external wall of the tooth: the antero-external angle is sharp and pointed; there is a single vertical costa on the dorsum, situated at a distance of 4 inches from the antero-external angle. The measurements of this specimen are as follows:—

					In.
Anterior side	...	...	...	...	2·1
External side	...	...	...	...	2·5
Posterior side	...	...	...	...	2·0
Height of crown	...	...	...	...	2·8

A figure of an ultimate upper molar of the right side of *Rhinoceros platyrhinus* is given in the "Fauna Antiqua Sivalensis"; in this it will be seen that there is no antecrochet, as in the present specimen, and the crochet is of much smaller size, not extending right across the valley, while the anterior valley is scarcely distinct from the cingulum; the dimensions given below are also much larger than those of the present specimen; tending to confine the distinctness of the two forms.

The measurements of the ultimate molar of *R. platyrhinus* given by Dr. Falconer are as follows in inches:—

Length (external side)	...	...	...	...	3·2
Breadth (anterior side)	...	...	...	...	2·8
Height of crown	...	...	...	...	3·1

The Nerbudda species of *Rhinoceros* must, therefore, have been considerably smaller than *R. platyrhinus*, which, apart from other characters, would probably be sufficient to establish its distinctness.

The last upper molar of this species is distinguished from the last molars of *R. sumatrensis* and *R. javanicus* by the presence of a combing-plate and an antecrochet, and by the greater size of the crochet, and by the presence of three fossettes instead of two on the worn crown-surface.

The last molar of *R. indicus* has a combing-plate, an antecrochet, and a large crochet; the combing-plate and antecrochet do not, however, unite, so as to divide the median valley in *R. indicus* as they do in the present species: moreover, the crochet of the former species is recurved at its extremity, and passes up the median valley between the combing-plate and the antecrochet. The crown of the present

specimen is considerably more "hysodont" than that of the last molar of *R. unicornis*, being absolutely higher and also narrower at the base.

It is to be hoped that eventually the skull of this species will be obtained from the Nerbudda valley, that we may have more complete evidence as to the distinctness of the species. The lower molars are unknown.

RHINOCEROS IRAVADICUS, N. SP. NOBIS. Plate 5, figs. 1 and 2.

The species is founded on two upper molars from the mammaliferous strata of Ava (*plate* 5, *figs.* 1, 2); both specimens are in the Indian Museum.

The most worn of the two molars (*fig.* 1) was discovered in a pagoda at Prome, and presented to the Indian Museum by Colonel Phayre; from its mineral condition there can be no doubt but that it is derived from the bone beds of the Irawádí valley. The crown is complete, with the exception of a small triangular piece of enamel chipped from the outer wall; the "fangs" have been broken off close to the neck. The tooth has been in wear for a considerable period, the height of the anterior collis above the neck being only ·9 inch. The specimen is from the left maxilla; and from its large size and elongated shape is probably the penultimate true molar. This is the specimen referred to by Mr. Foote in his Memoir on *R. deccanensis*, in the first part of this volume (p. 16).

The anterior collis (*on the left side of the figure*) is of much greater size than the median (*on the right side of the figure*), occupying nearly one-half of the internal face of the tooth; on its inner side it slopes away slightly from its base downwards to the outer side; on its posterior side, it gives off a blunted antecrochet, projecting into the median valley (*the centre of the figure*) internally to the crochet. The anterior surface of the tooth has a projecting angle (*the centre of the left border of the figure*) in the middle of its course; the cingulum commences at this angle, and is continued as a distinct ledge up to the antero-internal angle of the tooth; there is a very small and shallow anterior valley between the cingulum and the anterior collis; along the internal surface of the anterior collis the cingulum may be traced as a slight wavy line on the enamel, and as a still fainter line on the median collis.

The entrance to the median valley is blocked by a large ovate tubercle, vertically grooved on its internal surface; this tubercle is continued outwards along the bottom of the median valley as a rounded ridge. The median valley runs, from its commencement, forwards and outwards, becoming deeper as it advances; it is of great width throughout its extent; its transverse diameter at the entrance is ·4 inch, and at its narrowest part, caused by the projection of the crochet, ·2 inch; throughout its length it preserves a considerable width along the bottom; the bases of the colles being nowhere contiguous.

The walls of the median collis are more abrupt than those of the anterior; the crochet is short and blunt, not projecting more than half way across the valley;

the posterior valley (*in the middle of the right side of the figure*) is very deep, and almost perfectly oval in form; the pass leading into this valley from the posterior side of the tooth is divided by a median fissure.

The antero-external angle of the tooth (*left-hand top-corner of the figure*) is produced into a prominent vertical buttress (as in *Rhinoceros javanicus* and *R. sivalensis*) divided by a median groove, so that the enamel in this part of the crown-surface forms two contiguous arches. Owing to the depth of the outer end of the anterior valley, the worn-crown would present an isolated fossette at this point, or two fossettes in all.

On the dorsum, the free edge forms a nearly horizontal line; the surface is concave antero-posteriorly. The costæ of the buttress do not extend as far as the neck of the tooth. The measurements are as follows :—

	In.
External side	2·6
Internal side	1·9
Anterior side	2·7
Posterior side	2·0
Thickness of enamel on outer side	0·1
Ditto on sides of median valley	0·06
Width of base of anterior collis	1·0
Ditto median ditto	0·7
Height of summit of tubercle above neck	0·4
Height of lowest part of cingulum above neck	0·5

The other specimen (*plate* 5, *fig.* 2) is from the bone-beds of the Irawádí; it is the second upper molar of the right side. The whole of the grinding surface is complete, but a considerable portion of the base of the external wall and the anterior angle has been broken away; the crown is much less worn than that of the last specimen.

The tooth being of the same form as the last, it is only necessary to note a few points.

The median collis (*on the left side of the figure*) is somewhat twisted upon itself, and constricted in the middle: the pass into the posterior valley (*the middle of the left side of the figure*) is more deeply cleft than in the last specimen, the outer half being higher than the inner.

The crochet becomes gradually thinner towards its summit, and is sharply bent inwards on itself; a small process of enamel is seen at the outer extremity of the median valley, which may, perhaps, be the rudiment of a combing-plate. The measurements of this specimen are as follows :—

	In.
Length of external surface	2·6
Ditto internal surface	1·9
Ditto anterior surface	2·2
Ditto posterior surface	2·0

The characteristics of the upper molars of this species may be shortly summarised as follows :—

"Buttress at antero-external angle; anterior collis the larger; crochet simple and blunt; median valley very wide; broad tubercle at entrance; blunt antecrochet and anterior collis. No combing-plate, and only two fossettes on the worn-crown."

The only one of Falconer's three species of Siwalik *Rhinoceros* to which the molars of the present species have any resemblance in form is *Rhinoceros sivalensis;* the teeth of both these species agree in having a buttress at the antero-external angle, in the anterior collis being larger than the median, in the absence of a combing-plate, and in the presence of two fossettes only on the worn-crown.

They are distinguished by the following points :—

In *R. sivalensis* there is no antecrochet; neither is there any tubercle at the entrance to the median valley, nor any trace of a cingulum on the inner surface. The median valley is very wide in *R. iravadicus,* and very narrow in *R. sivalensis.* The cingulum on the anterior surface of the latter is cleft, and forms a wall above a distinct anterior valley; in the former this cingulum is not cleft, and merely forms a flat ledge, without any distinct anterior valley: the process at the postero-external angle is much more produced in *R. sivalensis* than in *R. iravadicus.*

From the molars of *R. palæindicus* the present specimens are distinguished by the presence of only two fossettes on the worn-crown; and from those of *R. platyrhinus* and *R. namadicus* by the absence of the combing-plate and by the presence of two fossettes only on the crown.

There is no marked resemblance between the molars of any of the European species and these specimens; from the molars of *R. tichorhinus, R. leptorhinus,* Cuv., *R. hemitæcus,* Falc., and *R. Indicus,* the present specimens are distinguished by the absence of any combing-plate.

The presence of the large tubercle in the median valley distinguishes the teeth of *R. iravadicus* from those of *R. etruscus,* Falc., and *R. deccanensis,* Foote.

From *R. sinensis* of Owen they are distinguished by most of the above characters, and by the fact of the median valley becoming deeper as it passes outwards, instead of becoming shallower.

They approach nearest in form to the molars of the recent *Rhinocerus sumatrensis* and *R. javanicus;* all the species having the buttress at the antero-external angle and the wide median valley, with occasionally a small tubercle at the entrance; they are, however, distinguished by the nearly horizontal line formed by the free boundary of the dorsum, in place of the angulated line of the recent species; the two colles are more equally sized in the recent species, the anterior valley smaller, and the cingulum less marked: the crochet is larger and extends further across the valley in the recent species; and from the larger diameter of the median collis, the posterior valley is smaller. It is, however, quite probable that the *Rhinoceros* of the Irawádí may have been the direct ancestor of the recent

Rhinoceros sumatrensis, now inhabiting the same regions of Asia. The measurements of the penultimate upper molar of *Rhinoceros sumatrensis* are—

	In.
External side	2·0
Internal side	1·4
Anterior side	2·0
Posterior side	1·6

These measurements indicate a tooth rather smaller, but having the same relative dimensions as that of the Irawádí species.

In addition to the molar teeth described above, I have discovered, in the Indian Museum among some bones brought from Pegú, some years ago, portions of the occiput of a species of *Rhinoceros;* these have been placed in the their relative positions and drawn (*plate* 5, *fig.* 3) with an approximate outline of the whole occiput. From the large size of the fragments, and from the locality in which they were found, as well as from the difference of their form from the occiputs of either of Falconer's three species of Siwalik *Rhinoceros*, I have no doubt but that they belonged to the large *Rhinoceros iravadicus* of Burma.

The fragments consist of two detached portions of the occiput, as shown in the figure; one of these comprises the left half of the lower portion of the occiput, with the condyle, partly broken on its lower border, of the same side. The second fragment consists of the central portion of the upper half of the occiput, showing the crest or superior curved line, and the depressions for the attachment of the cranio-cervical muscles; a small portion of the parietals between the temporal fossæ, with parts of the latter, are also attached to the specimen. I cannot be quite sure whether the relative positions of the two fragments are rightly placed in the figure or not; I made the interval between the summit of the condyle and the summit of the occiput equal to two and a half times the long diameter of the former, this being the average interval between the two points in the skulls of such species of *Rhinoceros* as I have had an opportunity of observing. As the specimen is in too imperfect a condition for exact description, I have given its measurements below, and then compared it with the figures of the occipital regions of the three Siwalik species figured in the Fauna Sivalensis:—

Long diameter of condyle (partly broken)	3·6
Short ditto	2·4
Width of occiput above condyles	13·5
Width of upper fragment	7·0
Height of ditto	5·4
Width of parietals 1½ inches in advance of occipital crest	1·8
Height from lower border of occipital foramen to crest (?)	10·10
Between external angles of condyles	6·3
Height of foramen magnum	2·4

From *Rhinoceros sivalensis* and *R. palæindicus*, this specimen is at once distinguished by its greatly superior size; the interval between the lower border of

the foramen magnum and the summit of the occipital crest of the specimens of the above species figured in the "Fauna Antiqua Sivalensis" is respectively 9 and 7·7 inches; while that of our specimen is at least 10·10 inches and perhaps rather more; the height of the occipital foramen in Falconers two species is 1·9 and 1·2 inches respectively; and the interval between the external angles of the condyles 4·8 inches. These measurements are much smaller than those of the present specimen. The dimensions of the condyles of the Siwalik species are not given.

The occiput of *R. palæindicus* is further distinguished from the present specimen by the great width of the parietals betweeu the temporal fosse,—nowhere less than 3·4 inches; further, the occiput of *R. palæindicus* drawn in plate 74, fig. 2*c* of the "Fauna Antiqua Sivalensis" differs from the present specimen not only by its much smaller size, but by the square form of the upper half of the occiput, and by the absence of the unusually deep lateral fossæ, and the large median tubercle seen beneath the crest of the present specimen.

Of *R. sivalensis* there is no figure of the occipital crest given in the "Fauna Antiqua Sivalensis;" the parietals of *R. sivalensis,* between the temporal fossæ though in a much smaller specimen, are wider than in our specimen; the relative size of the two is, however, a quite sufficient distinction.

Between our specimen and the occiput of *Rhinoceros platyrhinus,* which is the only one of the Siwalik species which approaches it in size, there are very wide and well-marked differences. An excellent figure of the occiput of *R. platyrhinus* is given in the "Fauna Antique Sivalensis" (*plate* 72, *fig.* 2). On comparing this with the figure of the present specimen, the two will be seen to differ greatly in the length of the vertical diameter; this, however, cannot be relied upon, owing to the conjectural restoration of the present specimen. The condyle of this specimen, though broken, is slightly larger than that of *R. platyrhinus,* and the breadth of the occiput is also rather larger. The occipital crest, however, at once distinguishes the two; the superior border of this is broad and convex in *R. iravadicus;* in *R. platyrhinus* it is narrow and with a median excavation; so that the surface of the parietals between the temporal fossæ in the latter species, as is seen in the crest of Colonel Baker's cranium, is concave, and placed considerably below the outer borders of the crest. In the present specimen this surface of the parietals is flat or slightly conven, and forms the highest part of the cranium. The narrowest part of the parietals in the Siwalik species is 3·3 inches, while the narrowest part remaining in the present specimen is only 1·8 inches. The whole of the upper part of the occiput beneath the crest in *R. platyrhinus* is somewhat hollowed, but not deeply so, and with no prominent median projection; entirely wanting the wide and deep hollows of the present specimen.

The above description or comparison, although, from the state of the materials, necessarily incomplete and crude, serves nevertheless to confirm the conclusions previously arrived at from the study of the upper molar teeth as to the specific distinctness of the large fossil *Rhinoceros* of the valley of the Irawádí: it may be

expected that further researches will bring to light more perfect specimens for future examination and description. The lower molars of this species are unknown, as we have none of these teeth from Burma in the Indian Museum.

RHINOCEROS PLANIDENS, N. SP. NOBIS. Plate 4, figs. 7, 9.

The two upper molars of this species (*plate* 4, *figs.* 7 *and* 9) were collected by Mr. Theobald in the Siwaliks; the specimen drawn in fig. 9 is from the left side; that in figure 7 is from the right side. Fig. 9 shows the median collis, and posterior and median valleys, with the adjoining half of the anterior collis; figure 7 comprises the whole of the internal half of the crown; the summit of the median collis is broken off; unfortunately neither of the specimens show the dorsum. The teeth present a good many points of resemblance to the Burmese specimens, but also show other points of divergence, which, taken together with the wide distance between the localities from which they were obtained, fully justify specific distinction.

The median valley is wide at the entrance, and, as in the Burmese and the other Siwalik species, becomes deeper as it passes outwards; so that the worn-crown would present an isolated enamel pit. The crochet is blunt and simple, and does not extend more than half-way across the median valley. The antecrochet is much larger than in the Burmese species, bounded by a deep vertical groove at its internal border.

The tubercle at the entrance to the median valley is much wider than in *Rhinoceros iravadicus*, and its inner border is nearly on a line with the inner border of the tooth, instead of being considerably external to it; the outer side of this tubercle descends suddenly to the bottom of the valley; externally to the antecrochet the valley is continued as a mere line between the bases of the colles, which are contiguous, the broad floor of the valley of the Burmese specimens being absent. This narrowness of the bottom of the valley is caused by the greater proportionate size of the median collis, the two colles being nearly equal in diameter; the diameter of the base of the anterior collis is ·9 inch, and that of the median collis ·8 inch.

The anterior valley (*seen on the right side of fig.* 7) forms in this species a distinct cavity, instead of a flat surface as in *R. iravadicus;* the cavity is triangular and bounded by the continuation of the cingulum; externally to this valley the enamel of the crown is sharply folded on itself, and is of the same thickness as on the inner side of the tooth. On looking at the corresponding part of the Burmese tooth (*the centre of the left side of fig.* 1, *plate* 2), the enamel is seen to have almost entirely disappeared at this point, and to have no trace of the fold. The folded portion of the enamel of the Siwalik specimen forms a thick isolated ledge on the side of the tooth, at a point where there is no appreciable coating of enamel at all in the Burmese specimen.

The cingulum commences in the middle of the anterior surface of the tooth, and is continued as a distinct ledge round the whole of the anterior collis (*right*

side of fig. 7), joining on to the median tubercle, which thus appears to be merely a portion of the cingulum, and is not isolated as in *Rhinoceros iravadicus.* The cingulum is continued posteriosly for a very short distance along the internal face of the median collis (*left side of fig.* 7 *and right side of figure* 9); it then stops abruptly, and for a space of half an inch in length, this surface has no trace of a cingulum; posteriorly to this space the cingulum again suddenly commences as a bold wide ledge (*well seen in fig.* 9) very different from the slight cingulum at this part in the Burmese specimens (*right side* of *fig.* 1, *plate* 5). This ledge, two-tenths of an inch in width, is continued along the posterior surface of the tooth till it joins the outer wall of the posterior valley. The pass to the posterior valley is very sharp (while it is broad and flat in *R. iravadicus*), and the valley itself long and oval, and less deep than in the Burmese species.

The cingulum is placed much higher up on the crown than in *R. iravadicus;* its lowest portion is ·8 inch above the neck of the tooth : the height of the summit of the median tubercle is ·7 above the neck. In consequence of the median tubercle being situated externally to the entrance of the valley, instead of within it, as in *R. iravadicus,* the interval between its summit and the outermost portion of the median valley is greater. This interval in the Siwalik specimens is respectively 1·6 inches and 1·7 inches, while in the Burmese specimens the same interval is only 1·2 inches. The interval between the centre of the pass leading into the posterior valley, and the centre of the internal surface of the median collis, is in the Siwalik specimens 1·1 inches, and in the Burmese species 0·9 inch. The length of the internal surface of the specimen drawn in figure 7 is 2·2 inches, or ·3 inch longer than the corresponding surface of the molar of *R. iravadicus;* the antero-posterior diameter of the anterior collis, taken through the antecrochet, in the specimen drawn in figure 7, is 1·3 inches; the corresponding line in the molar of *R. iravadicus* is 1·1 inches. From the parallelism of the dentine-surfaces of the two colles in the molars of *R. planidens,* I am inclined to think that the antero-external angle of the tooth was not produced into a buttress. The worn-crown would present two permanent fossettes only, although for a very short period there might be a very small third fossette, placed internally to the crochet, the median valley being very shallow at the crochet.

The molars of this species are distinguished from those of *R. sinensis* by the presence of the tubercle at the entrance of the median valley, and by the valley becoming deeper as it passes outwards.

From the molars of *R. sivalensis* the present specimens are distinguished by the presence of the large tubercle at the entrance to the median valley, and the very prominent cingulum on the inner and anterior surfaces, as well as by the presence of the large antecrochet and the temporary third fossette.

The presence of only two permanent fossettes on the crown distinguishes the present specimens from the molars of *R. Indicus, R. platyrhinus, R. namadicus,* and *R. palæindicus.* The absence of any combing-plate distinguishes these teeth from

those of *R. etruscus*, Falc., *R. tichorhinus*, and *R. leptorhinus*, Cuv.; the presence of the tubercle at the entrance to the median valley distinguishes them from the upper molars of *R. etruscus* and *R. deccanensis*.

The great width of the median valley, the large antecrochet, and the unusual size of the tubercle at the entrance, together with the wide cingulum on the posterior side, apart from other characters, are amply sufficient to distinguish these specimens from the molars of *R. sumatranus* and *R. javanicus*.

Rhinoceros, sp. var.

In addition to the above species of *Rhinoceros*, we have in the Indian Museum, various upper premolar and lower molar teeth which I am unable to refer to any of the above species, but of which I do not think it desirable at present to establish new species. The first of these specimens (*plate* 6, *fig.* 6) is an upper molar, or premolar tooth brought by Mr. Fedden from Sind: the specimen is from the left side of the upper jaw, and is complete with the exception of the dorsum, which is broken away; from its small size it is probably a premolar.

The general shape of the crown is squared, with the postero-internal angle rounded off; the transverse diameter of the tooth, when complete, probably exceeded the antero-posterior. The two colles are approximately equal in size, and their worn dentine-surfaces are directed obliquely to the median transverse line of the tooth, and run outwards and forwards in parallel directions; there is a vertical groove on the antero-internal surface of the anterior collis (*right of figure*).

A cingulum surrounds the greater portion of the crown; this commences at the posterior valley (*hollow on left of figure*) as a flat-topped ridge, reaching nearly to the summit of the median collis (*left of figure*); it descends obliquely along the front of this collis, forming a waving line on its anterior surface. Between the two main colles (*centre of base of figure*) at the entrance to the median valley the cingulum forms a wide ledge; this becomes narrower on the inner surface of the median collis, and again expands into a broad ledge along the whole of the anterior surface of the tooth (*right side of figure*). There is no distinct anterior valley. The median valley does not properly commence at the gap between the two colles above the cingulum, as is generally the case. Interiorly to the cingulum the two colles are connected nearly up to their summits; on the outer side of this pass there is a sudden descent into the median valley; this valley is consequently very short and becomes deeper as it passes outwards. A triangular crochet projects about three-fourths of the way across this valley; there is no combing-plate. The posterior valley is somewhat heart-shaped at its summit, becoming more circular as it descends. The greatest length of the tooth is 1·35 inches, and the height of the crown ·9 inch.

Following my usual rule, I have not made a distinct species upon the evidence of this solitary premolar tooth, though I think it extremely probable that it is distinct from all the species noticed above.

The presence of the surrounding cingulum and the position of the pass into the median valley sufficiently distinguish it from Falconer's three species of Siwalik *Rhinoceros*, and from the Nerbudda and Burmese species.

The only one of the above noticed species with which I think the present specimen can have the least affinity is *R. planidens* of the Siwaliks. The general form of the cingulum is, however, very different in the two : in the present specimen this continues in a straight line along the whole of the anterior surface, whereas in *R. planidens* it bends to form a distinct anterior valley, and does not extend more than half-way across the anterior surface of the tooth ; the cingulum, moreover, in the latter species does not extend completely across the inner surface of the median collis, as in the present specimen.

The greatest difference, however, is found at the entrance to the median valley in the two specimens : in *R. planidens*, the cingulum forms a distinct tubercle at the entrance to the median valley, and the top of this tubercle becomes the pass into the valley, there being no contact of the base of the collis further in.

These differences are so great that I do not think the two specimens can belong to the same species : at the same time it is not quite impossible, as considerable variations do sometimes occur between the molar and premolar series of the same species.

The only described species of *Rhinoceros* with which this specimen agrees at all closely is *R. deccanensis* of Mr. Foote. The premolars of that species (*plate* 1 *of the first part of this volume*) are of exactly the same general form and type as the present specimen. They both have a complete cingulum, are of the same size, and have the same internal pass between the colles into the median valley. The main differences I can detect between the two are the following : in *R. deccanensis* the cingulum forms a more complete collar round the crown, it makes a distinct ledge on the inner surface of the median collis, instead of only a waving line ; while on the anterior surface it is raised up into a sharp edge on its free border, and so forms an anterior valley, instead of a flat ledge. The pass between the colles is still further away from the cingullum in the present specimen than in *R. deccanensis* ; and in the latter there is not the vertical groove on the antero-internal surface of the anterior collis. Further, the lowest part of the cingulum in the premolars of *R. deccanensis* is opposite to the pass between the two colles ; the cingulum rises continuously on either side from this lowest part ; on the anterior surface the cingulum is higher than on any part of the internal surface of the anterior collis. In the present specimen the cingulum has its lowest level along the anterior surface ; the portion on the internal surface of the anterior collis is higher than that on the anterior surface.

I hope that further specimens will subsequently be acquired which will further elucidate the affinites of this specimen ; for the present I think that it is probably a distinct species. Its relationship with the Deccan *Rhinoceros,* the two separated far in time and space, is very interesting, as I pointed out in my papers on tertiary

mammals (Rec. Geol. Surv. Ind., Vol. IX), the Deccan fossil species showed affinites to older forms, especially in the presence of its large cingulum; the present specimen shows another link in the chain which relates it to the extinct *Rhinocerotes* and *Acerotheria* of the European Miocene beds.

The specimen drawn in plate 5, figure 4, is a portion of the right maxilla of a species of *Rhinoceros*, containing two teeth, from Burma, in the Indian Museum. At the distal extremity of the bone (not shown in the figure), there is the alveolus of a third tooth, containing portions of the "fangs." This tooth will probably be the second premolar, as the first usually falls out at an early period; consequently the two teeth drawn will be respectively the third and fourth of the premolar series. At the proximal extremity of the bone (*also omitted in the figure*) are the imbedded fangs of a *fourth* much larger tooth, which, if this view be correct, will be the first of the true molar series: these teeth are referred to by Mr. Foote in the first part of this volume (p. 16).

The penultimate premolar (*on the right side of the figure*) is complete and uninjured; a portion of the enamel of the anterior collis of the ultimate premolar has been broken away, and a caste of the dentine only remains.

Taking first the penultimate premolar, we find the external surface or dorsum of the tooth divided into two equal portions by a prominent vertical costa; the antero-external angle (*the right upper angle of the figure*) is wedge-shaped and slightly produced; the anterior side is angulated in the middle, and set obliquely to the outer side. The anterior and median colles are of nearly equal diameter; the latter gives off a sharp wedge-shaped crochet, small and simple; it projects about half-way across the median valley. A large combing-plate is given off from the outer wall of the valley; this plate is thicker at its free extremity than at its origin: the free extremity is separated by a small interval from the crochet; the worn-crown would present three fossettes. The pass leading into the median valley is very low, nearly at the base of the crown; it is of considerable length, running as a level line between the contiguous bases of the colles for a distance of rather more than a quarter of an inch, at which point there is a sudden descent into the expanded valley: there is no tubercle at the entrance of the valley.

The cingulum occupies almost the whole of the anterior side of the tooth, and forms a distinct ledge; there is no cingulum on the inner side; the anterior valley is scarcely distinguishable. The posterior collis (*on the extreme left of the figure*) is small, though distinct, separated by a channel from the median collis; the posterior valley is large and nearly circular with a sharp narrow pass. The measurements are as follows :—

		In.
External side	... ...	1·4
Internal side	... ...	0·9
Anterior side	... ...	1·2
Posterior side	... ...	1·1

The ultimate premolar is larger than the other; it resembles the penultimate, with the exception that the costa on the dorsum is placed, not mesially, but close to the antero-external angle. Its measurements are—

	In.
External side	1·8
Internal side	1·2
Anterior side	1·7
Posterior side	1·4

As these teeth belong to the premolar series, which is subject to considerable variations in the same species, it would not be safe to found a new species upon their evidence alone, although I doubt if they can be referred to any of the described forms: Mr. Foote considers them as belonging to a second Burmese species.

The premolars of *Rhinoceros iravadicus,* as in the recent *Rhinoceros sumatrensis,* probably had a buttress at the antero-external angle, were nearly quadrate in form, and had a wide open valley, without any combing-plate.

A figure of the premolar of *Rhinoceros palæindicus* is given on plate 4, figure 3, which will be seen to have no resemblance to the present specimens; the ultimate premolar of that species has but one costa on the dorsum and no combing-plate.

In plate 73, figure 26, of the "Fauna Antiqua Sivalensis," the premolars of *Rhinoceros sivalensis* are shown: they are quite quadrangular in form, with no very prominent costa, no combing-plate, a narrower valley, and only two fossettes on the worn-crown.

With *Rhinoceros platyrhinus* the present specimens are connected by the presence of a combing-plate: this, however, is the only point in common. The premolars of Colonel Baker's specimen of *R. platyrhinus* in the British Museum are double the size of the present specimens, are more quadrangular in form: they have two costæ on the dorsa of the whole of the series, and their external border is quite straight and never like that of the second of the present specimens; while the combing-plate and crochet are of much larger proportionate size, and closely approximated.

The premolars of *Rhinoceros deccanensis* are distinguished by the cingulum encircling the whole of the internal surface.

The same remarks apply to *Rhinoceros planidens* as to *R. iravadicus.*

We do not know the form of the premolars of *Rhinoceros namadicus,* though they no doubt had a combing-plate, and were somewhat oblique. The specimens might possibly belong to that species, though the distance of the localities and the difference of the age of the beds in which the two specimens occur tells somewhat against it.

The specimen drawn in plate 6, figure 10, is from Siwalik strata, and is in the collection of the Asiatic Society of Bengal; it belongs to the right maxilla of a species of *Rhinoceros.* As there is no disc of pressure on the anterior side it is pro-

bably the first, or perhaps second (the first disappearing), of the premolar series. The anterior wall of a larger succeeding tooth is seen on the left side of the figure. The specimen is quite complete; it had only just come into use, the tip of the anterior collis and the anterior part of the external wall being the only portions flattened by abrasion.

The tooth is remarkable for the excessive prolongation of the antero-external angle (*the angle on the right of the figure*) in a manner unlike that of any other recent or fossil form that I have seen. From the presence of a combing-plate the tooth belongs to the type of *R. platyrhinus* and *R. namadicus*; but differs entirely in form from the premolars of the first of these species, which, as shown in Colonel Baker's cranium, are nearly square.

The dorsum has three costæ, one at the posterior angle (*left of figure*) and two others placed at equal distances in advance of this, the anterior one occupying the middle of the dorsum; from this anterior costa the dorsum slopes away to the antero-external angle. The anterior collis on the right of the figure is very small, with a concave border towards the median valley; the dentine surface proceeding from this collis towards the outer wall of the tooth runs obliquely forwards so as to be almost parallel with the posterior half of the outer wall.

The median collis (*on the left of the figure*) is larger than the anterior; it gives off a long sinuous crochet, stretching far into the median valley: from the external wall of the tooth there are two long and slender combing-plates, parallel to one another; the posterior of these unites with the extremity of the crochet, while the anterior joins the anterior crochet; a third small process occupies the angle between the posterior combing-plate and the outer wall.

The median valley is entered by a low pass, without any tubercle at the entrance; it extends far up towards the antero-external angle of the tooth, and is of larger extent than in any other described tooth.

Along the anterior side there is a wavy cingulum, but little raised from the surface; there is no distinct anterior valley. The posterior valley is large and nearly circular, entered by a high and narrow pass.

The measurements of this specimen are—

	In.
External side	1·6
Internal side	0·6
Anterior side	1·4
Posterior side	1·3

The specimen differs from the preceding Burmese specimens by the greater production of the antero-external angle, by the small size of the anterior collis in proportion to the median, by the double combing-plates, and by the slighter cingulum, and by the absence of the anterior valley. It belongs to the hypsodont type, though tending towards the brachydont. The only species to which it could possibly belong is *Rhinoceros namadicus;* and until a larger series of the molars

of that species be discovered, it cannot be said that it does not. Possibly, however, from its very aberrant form, it belongs to yet another undescribed Siwalik species. The premolars of *R. platyrhinus* have each two costæ on the dorsum. The ultimate premolar of *R. palæindicus* has a large median costa on the dorsum, but no combing-plates. In Falconer's figure of a premolar of this species there is no costa on the dorsum.

The tooth figured in Plate 6, Figure 9, was collected by Mr. Theobald in the Siwaliks; it is probably either the milk molar or a premolar of the left maxilla of a species of *Rhinoceros*. The crown is perfect with the exception of a few chips out of the enamel; it is about a third worn down.

The configuration of the crown surface presents some very remarkable peculiarities which I have not seen in any other specimens of *Rhinoceros* molars. The crown surface is approximately square, with a slightly produced antero-external angle; the external surface or dorsum is nearly plane, having only a very slight costa half-an-inch behind the anterior border. On the anterior surface (*the left side of the figure*) a slight cingulum occupies the internal half; between this and the external side of the anterior collis (*left lower angle of the figure*) there is a small oval anterior valley (*the pit on the left side of the figure*) placed more externally than usual. The anterior and median colles are of nearly the same diameter: their internal walls are nearly vertical, with no trace of any cingulum on them.

The anterior collis (*left of figure*) has a somewhat triangular cross-section. Instead of being connected by a column of dentine with the dentine of the outer wall of the tooth, the anterior collis forms a completely isolated pillar, there being a narrow pass on its outer side connecting the anterior and median valleys. This pass is so low that it would not be touched by wear until the crown became worn down to the level of the cingulum. I have seen no other specimen, either recent or fossil, in which the anterior collis is isolated in a similar manner.

The entrance to the median valley (*middle of lower border of figure*) is by a narrow pass, slightly higher than the level of the cingulum, and without any tubercle at the entrance. Externally to the pass the descent into the valley is very abrupt and steep; the extremity of the valley is nearly half-an-inch below the level of the pass.

The median collis (*right lower angle of figure*) is united to the external dentine wall by a very narrow neck of dentine, running at first forwards and outwards, and then bent back on itself. On its anterior side this neck gives off a very small bifurcate crochet, projecting about half-way across the median valley. On its posterior side the dentine neck gives off another bluntly conical process, projecting into the posterior valley (*the pit on the right side of the figure*); the narrowness of this dentine neck and the posterior process are quite unusual.

In consequence of the narrowness of this neck, the posterior valley is of large diameter: its external wall is nearly vertical, and its anterior and posterior walls sloping: the pass into this valley is very sharp and abrupt.

The dimensions of this specimen are—

	In.
Anterior side...	1·6
Internal side...	1·2
External side	1·6
Posterior side	1·7

The lower molar figured in Plate 6, Figure 7, is the antepenultimate tooth of a right mandible of a *Rhinoceros* from the Siwaliks, different from either of the three species of Falconer. The specimen is in the collection of the Asiatic Society of Bengal; there is also a detached portion of the same jaw containing the ultimate and penultimate teeth. The state of wear of this specimen is about the same as that of the last. Dr. Falconer described this specimen as a milk molar, but he was, apparently, not aware that the next specimen in the catalogue belonged to this jaw. The tooth differs from the lower molars of any other species of *Rhinoceros* that we have seen, in the great relative size of the anterior collis (*left of figure*) which projects on the inner side in advance of the other colles. The anterior valley is large (*left of figure*) and of equal depth with the posterior (*right of figure*); on the worn-crown, therefore, the two valleys would remain, as notches on the inner side, for an equal period. The outer end of the anterior valley is rounded, and that of the posterior valley angulated; the three worn dentine surfaces leading from the colles are nearly parallel, and placed obliquely to the longer anis of the tooth.

On the anterior side of the tooth, the enamel of the crown shows a transverse section of two vertical costæ; these extend downwards to the base of the crown. On the anterior side of the median collis (*middle of figure*) there is a slight infolding of the enamel, and other crenulations may be seen on the outer wall. The posterior collis (*right of figure*) has its inner extremity expanded antero-posteriorly. In the middle of the inner border of the posterior valley (*right of figure*) there is a simple ovate tubercle detached from the posterior collis. There is no cingulum on the inner face of the tooth; but a small, though distinct cingulum, occurs both on the anterior and posterior surface. The length of this tooth is 1·8 inches, and the width ·9 inch.

The succeeding tooth of this jaw (*A. S. B. No.* $\frac{S.}{323}$) is unworn; it has the same form and the same crenulated enamel as the figured specimen; the tubercle in the posterior valley is, however, considerably larger. The length of the tooth is 2 inches.

The large anterior collis, the crenulated enamel, and the tubercle in the posterior valley, sufficiently distinguish the tooth from the figured Siwalik specimens; but it would be somewhat unsatisfactory to found a new species on a lower molar only.

The specimen drawn in Plate 6, Figure 3, is another right lower molar of a species of *Rhinoceros*, different from any of those described above. The tooth is

from tertiary beds at Kushalghar, near Attock, the precise age of which has not yet been determined. A portion of the posterior collis was broken, which has been restored in the figure.

The crown is very unsymmetrically shaped, the posterior valley (*right of figure*) being greatly larger than the anterior valley (*left of figure*); the posterior half of the tooth is worn down a quarter of an inch below the anterior half. The dentine surface joining the posterior collis with the outer wall of the tooth is situated obliquely to the long axis of the crown: the median collis exposes the largest dentine surface; its postero-internal angle is acute; the posterior collis (*extreme left of figure*) is smaller than either of the others, its innermost border not extending so far inwards as those of the other two colles.

The inner border of the tooth presents a nearly continuous wall for some distance up on the crown, which takes away from the prominences of the colles, usually so conspicuous in the lower molars of other species of *Rhinoceros.* The anterior valley is entered by a small and narrow pass through this innermost wall. The entrance to the posterior collis is blocked for half its length by the inner crown-wall. Behind this there is an open space of rather more than a quarter of an inch in width leading directly into the valley; the inner wall is again continued on the anterior aspect of the posterior collis. The narrow channel leading into the posterior valley is slightly higher than the bottom of the outer extremity of the valley. When the crown becomes worn down, the outer extremity of the posterior valley would be left as an isolated fossette upon the crown surface, the outer extremity of the valley disappearing last; in the lower molars of all other species of *Rhinoceros* which I have seen described, except those of *Rhinoceros simus* of Africa, which have the same peculiarity as this specimen, the posterior valley is shallower on the external than on the internal side, and consequently never forms an isolated fossette on the crown, but merely forms a shelving notch on the inner border. The whole of the anterior valley on this specimen would disappear at an early stage of wear. There is no cingulum on any part of the crown. The enamel is thinner on the inner than on the outer side of the tooth.

The flatness of the inner wall of the tooth, together with the peculiar shape of the posterior valley, sufficiently distinguish the specimen from the lower molars of any of Falconer's species of Siwalik *Rhinoceros;* the dimensions are—

	In.
Extreme length	2·2
Breadth at centre	1·2

A single lower premolar of *Rhinoceros merkkii* figured in *Gervais*' "Paléontologie et Zoologie" (*Plate XIV, Fig.* 3) shows a fossette on the worn crown, representing the posterior valley; but there is none on the molars of the same specimen.

I have but little doubt that this tooth belonged to another distinct species of *Rhinoceros,* which must have had affinities with the African *R. simus.*

GENUS ACEROTHERIUM, *Kaup*.

Of this genus we have one species in India; the species is only known by its molar teeth, which correspond in general form with those of the Miocene European species, but we have no means of knowing whether the Indian form was hornless, or whether the number of its digits were similar to those of the European genus.

ACEROTHERIUM PERIMENSE, FALCONER. *Plate* 6, *Figs*. 2 *and* 5.

The specimen drawn in figure 5 is a portion of a left maxilla from the collection of the Asiatic Society of Bengal, which was obtained in Perim Island in the Gulf of Cambay; it contains the last premolar and the first molar teeth. The other specimen in the same plate (*Fig*. 2) is a first molar of the left maxilla; this specimen with two others was collected by Mr. Theobald in the Siwaliks of the Punjab. These are the first recorded specimens from that formation. The Siwalik specimen is less worn than those from Perim Island, but the two agree precisely in size and form.

The molars of this species are distinguished from those of *Rhinoceros* by their transverse diameter exceeding their antero-posterior in length. The median collis (*right side of figures*) is slightly larger than the anterior collis (*left side of figures*). A cingulum surrounds the whole of the inner half of the crown and is lowest on the inner face. The median valley (*middle of lower border of figures*) is entered by a high pass. The bases of the colles are in contact at the pass. A small and blunt crochet is seen in Figure 2. In the Perim Island specimens this has become obliterated by wear; the direction of the upper portion of the valley is different from that of the bottom, so that the valley in the two specimens have contrary directions. A very small enamel island would be formed on the crown were the tooth worn down to the level of the cingulum. The posterior valley (*on the right side of the figures*) is small and oval; the inner wall slopes rapidly. The antero-external angle (*left top angle of figures*) forms a small buttress with two costæ; this angle is more bevelled away in the specimen drawn in Figure 2 than in the specimen drawn in Figure 5.

The measurements of the Perim Island molar are—

	In.
External side	1·5
Anterior side	2·5
Internal side	1·4
Posterior side	2·8

The premolar is less worn than the molar, and is almost square in shape. The cingulum has been partly broken away along the inner side. Its measurements are—

	In.
External side	1·5
Anterior side	1·4
Internal side	1·2
Posterior side	1·4

A figure of an unworn left molar of this species is given in the "Fauna Antiqua Sivalensis" (*Plate* 75, *Fig.* 15) from Perim Island.

The molar and premolar teeth of a right maxilla of *Rhinoceros* brought from Ava by Mr. Clift and figured in the Transactions of the Geological Society of London (*Second Series*, *Vol.* II, *Plate* 5) belong to the present species. Clift's figure is copied in Dr. Blainville's Osteography (*Atlas*, *Vol. III*, *Plate* 14). On the same plate there is another figure of an upper molar of the right side, also from Burma, belonging to the same species.

This species had therefore a very wide distribution, having been obtained from Burma, from the Sub-Himalayan Siwaliks and from Perim Island.

On comparing the above specimens with the upper molars of *Acerotherium incisivum* of Kaup., the general form of the two, though sufficiently different for specific distinction, is very similar, evidently belonging to the same type, and leaving no doubt in my mind that the Indian specimens are rightly placed in the sub-genus. In both species we note the excess of the transverse over the antero-posterior diameter of the crown (carried to the greatest extent in the Indian species), the wavy cingulum, surrounding the inner half of the tooth; the simple valley and single crochet; the direction of the median valley is the same in both species. The European species is distinguished by an antecrochet, nearly blocking the median valley on the inner side of the crochet.

The presence of *Acerotherium* among the Indian Tertian *Rhinocerotes* is another link connecting the faunas of early India and Miocene Europe; in the presence of the cingulum, and the simple form of the crowns of the molars, *Acerotherium* is a connecting link between the true *Rhinocerotes* and the *Palæotheria.*

Including the above new species and the living forms, we have the following large list of species of *Rhinoceros* (or its sub-genera), which have been described, from South-Eastern Asia; some of the modern species are, however, probably only varieties :—

R. nasalis, Gray.	*R. niger,* Gray.
R. indicus.	*R. namadicus,* Falc. *et nobis.*
R. javanicus.	*R. planidens, nobis.*
R. sumatrensis,	*R. sinensis,* Owen.
R. stenocephalus, Gray.	*R. deccanensis,* Foote.
R. sivalensis, Falc.	*R.* (*A*) *perimensis,* Falc.
R. palæindicus, Falc.	*R. iravadicus, nobis.*
R. platyrhinus, Falc.	

In addition to these there seems to be evidence of another species from Burma, another from Attock, and a third from Sind. The fossil *Rhinocerotes* of Asia therefore vie with the *Proboscidia* in the number of species. In the above list nine of the species are extinct, while the total number of living forms is only six. It must

also be remembered that many of the latter are distinguished simply on external characters—a kind of evidence not available in the case of fossil species.

Of three of the above fossil species, *viz.*, *R. sivalensis*, *R. palæindicus*, and *R. platyrhinus*, the crania, in a more or less complete state, have been discovered. The two first species were unicorn and the latter bicorn. The fossil forms do not bear out the relationship between the number of horns and the lower incisors which occur in the living species, and which Dr. Gray has taken as a character affording a distinction of sub-generic value. Among the living species, in the single-horned forms, the mandible has one pair of large outer incisors, and a smaller median pair; while the two-horned forms have only the outer pair of incisors present. Precisely the reverse of the above occurs among the Sivalik species: the bicorn *R. platyrhinus* has a pair of large outer incisors in the mandible, and a smaller central pair; while the unicorn *R. palæindicus* has the outer pair only. (*See "Fauna Antiqua Sivalensis," Plate* 74, *Fig.* 4, *and Plate* 75, *Fig.* 10.) Dr. Gray's distinction, therefore, founded, on this relationship, is not of real classificatory value, as it is confined to the species of *Rhinoceros* of one period only.

A statement made on the authority of Dr. Falconer regarding Siwalik Mammals, must of course meet with general acceptance; in relation, however, to our present subject, there is one which does not appear to me to be borne out by the facts at our command. In the "Introduction to the Siwalik Fauna" (Falconer's "*Palæontological Memoirs,*" *Vol. I, p.* 21), it is stated that *Rhinoceros sivalensis* was provided with six incisors in both the upper and lower jaws; that this statement was not a local error we infer from a passage in Owen's "Odontography," (*Vol. I, p.* 589), where it is asserted, from the verbal authority of Dr. Falconer, that one of the Siwalik *Rhinocerotes* was "hexaprotodont" in both jaws; this species can only be *Rhinoceros sivalensis.* None of the figures, however, in the "Fauna Antiqua Sivalensis" bear out this statement, as none of the incisor teeth of *R. sivalensis* are shown: a figure of the mandible of this species, however (*plate* 75, *Fig.* 6), shows the whole of the molar and premolar series, but no incisors. In this figure, the anterior premolars extend almost up to the symphysis of the mandible, precisely in the same manner as in the mandibles of *Rhinoceros leptorhinus* of Cuvier (*Owen, British Fossil Mammals, Fig.* 135), and of the African *Rhinoceros simus* (*De Blainville's Osteographie, Vol. III, Rhinoceros, Plate* 4), in both of which species there are no persistent incisors. In all recent *Rhinocerotes*, in which the lower incisors are persistent, the symphysis of the mandible is prolonged in a spatulate form, considerably in advance of the first premolar, and there is a very long diastema between the two series of teeth (*Owen's "Odontography," Vol. I, p.* 596). In the mandible of *Rhinoceros sivalensis* there seems to be no room for six incisors, even without a diastema, a condition quite unknown in any animals of this class. It appears to me that until some conclusive evidence of the hexaprotodont character of this species be forthcoming, we are quite justified in regarding it as being without permanent incisors. It is, to say the least, very remarkable that if

Falconer had a specimen showing these six incisors, he did not give a figure of it in the "Fauna Antiqua Sivalensis."

In the form of their complex molar teeth, furnished with a large crochet and combing-plate, *R. platyrhinus* and *R. namadicus* approach the living *R. indicus* of India; the lower incisors of *R. platyrhinus and R. indicus* have also the same form and arrangement. Dr. Falconer, moreover, considered the upper molars of *R. platyrhinus* to approach those of the European *R. tichorhinus.* Both these species also agree in having been bicorn. The lower incisors of *R. tichorhinus,* however, differ from those of *R. platyrhinus* in having been deciduous at an early period. The three species, *R. platyrhinus, R. tichorhinus,* and *R. indicus,* agree in having had spatulate mandibles, and combing-plates in the upper molar teeth.

The molars of the unicorn *R. sivalensis* are formed on the same plan as those of the European *Rhinoceros etruscus* (Falc.), but the latter was a bicorn species, and had a spatulate mandible without permanent incisors. The mandible of *R. sivalensis* is like that of the African *R. simus.*

The form of the cranium of the unicorn *R. palæindicus* is very like that of the unicorn *R. javanicus,* and the mandibles of the two species are alike furnished with large outer incisors; but the form of the upper molars is different. The upper molars of *R. iravadicus* and *R. sinensis* have their nearest representatives in those of the living *R. sumatrensis.*

The upper molars of *Acerotherium perimense* and of *R. deccanensis,* together with the upper premolar noticed above from Sind, are cingulated on the inner side like those of Kaup's typical forms of the sub-genus (or genus) *Acerotherium.* Whether any of these Indian forms were hornless or provided with four toes on the anterior limb, we have no means at present of knowing; the mandible of *R. deccanensis* was spatulate and edentulous in the adult state, as in *R. etruscus.*

The lower molar from Attock, described above, presents a peculiarity of structure which is only found in the living *R. simus* of Africa.

The affinities of the Indian fossil species of *Rhinoceros* are therefore widely spread, showing relationships to forms, both living and extinct, scattered over Europe, Asia, and Africa. Unless the hexaprotodont character of *R. sivalensis* can be proved, there seems to be no more generalised form among the fossil than among the living species; while the highly specialised outer and inner lower incisors is a character common to some of both fossil and living forms.

The difficulty of determining with accuracy the lower molar teeth, in the absence of the original type specimens, from the Siwaliks, has prevented me from making new species, in any case, on the evidence of these teeth alone. In the case of upper premolars I have followed the same rule, from the known liability of these teeth to vary in different individuals of the same species.

The three species of fossil Asiatic *Rhinoceros* described by Dr. Falconer belong to the hysodont type of Mr. Boyd-Dawkins; as does *R. deccanensis* and the three

new species described above; the molars of *R. iravadicus*, however, present a tendency towards the hysodont type, and they are characterised by the very open median valley, which is a remnant of a primitive type of tooth; the only true brachydont species is *A. perimense*. As all the Miocene species of European *Rhinoceros* belong to the brachydont type, while the Pliocene species and all existing species belong to the hypsodont or specialised type, the Siwalik species of *Rhinoceros* evidently belong to a modern group, and, as far as they go, are another argument for the Pliocene age of the deposits in which they occur; while the Irawadí species shows a tendency to an older type, and therefore confirms the conjecture as to the somewhat older date of these Irawadí beds.

I have lately seen a note in "Nature" (Oct. 1876, p. 572), in which an extract is given from a recent paper by Professor Flower (P. Z. S. 1876, p. 443) on the crania of *Rhinoceros*, in which the following interesting difference is pointed out between the skulls of the single and double-horned living species; in the former group, "the external auditory meatus is embraced below by the fusion of the post-glenoid and post-temporal processes of the squamosal portion of the temporal bone, whilst in the other these two processes remain separate." On looking at the skulls of our fossil Indian species, I find that in the crania of *R. sivalensis* and *R. palæindicus*—both single-horned species—these two processes are united; on examining the cast of Colonel Baker's cranium of *R. platyrhinus* (the original of which is in the British Museum)—a double-horned species—I find that in this species also the two processes are similarly united, the external auditory meatus forming a long tubular funnel, looking almost directly upwards, precisely as in the single-horned *R. indicus* (*unicornis*). This shows that Professor Flower's distinction between the two groups will not hold for the fossil Indian species; the union of the two processes is another point, in addition to the form of the upper molars, which connects *R. platyrhinus* with *R. indicus*, and lends support to the idea that the one may be the ancestor of the other.

Sub-Order: RUMINANTIA.

VISHNUTHERIUM IRAVADICUM, *nov. gen. nobis*, Burma. Pl. 7, figs. 1 and 2.

A short notice of the specimen on which this genus is founded was given by me in my paper on the Siwalik fauna (*Rec. Geol. Surv. Ind. vol. IX, pt.* 3); I now give a figure and a more detailed description of the specimen.

The specimen is a portion of the left ramus of the mandible; it contains the first and second teeth of the permanent molar series; these have only been in use for a short period; the animal was scarcely adult at the time of its death. The inner sides of the anterior barrel of the first molar, and of the posterior barrel

of the second, are broken away: at the anterior extremity of the fragment is seen the hindmost barrel of the last premolar, which has never been in functional use.

The teeth are implanted obliquely in the jaw, so that a line drawn across the teeth at right angles to its longer axis forms nearly an angle of 45° with the long axis of the jaw. The outer surfaces of the barrels are sharp in the middle, and slope away slightly from the base towards the inner side; the median valley which separates the two barrels is deep, and extends downwards almost to the base of the crown.

The hindmost surfaces of the outer halves of the barrels are somewhat concave. Along the whole of the outer portion of the teeth there is a well-defined and conspicuous cingulum; this is most marked on the anterior and posterior surfaces; it becomes slighter on the external surfaces of the barrels, and on the surfaces between the two barrels; on the anterior surfaces of the teeth the cingulum is raised into a number of points. In the median valley, which divides the barrels, there is a large pointed tubercle, blocking the entrance to the valley; the valley itself is narrow and becomes shallower as it passes inwards. The whole of the enamel for the outer half of the crowns is corrugated and roughened like that of *Sivatherium.*

On the crown surface the postero-internal angle of the anterior barrel (*middle of upper border figure*) forms the most prominent point on the inner side of the tooth; while the antero-internal angle is the least prominent point on this border. The central enamel folds of the crown are long and narrow, and they would not form complete islands until the tooth became considerably worn down. The outline of the inner border of the teeth is the same as in the molars of *Camelopardalis;* and the late period at which the folds of enamel on the crown become insulated is also a point common to the teeth of the two genera.

On the inner surface (*fig.* 1) we are enabled to see the forms of the costæ from the contiguous unbroken lobes of the two molars: on the anterior half of the second lobe there are three costæ, of which the median is the highest; the posterior and anterior costæ are of nearly equal height, the posterior being the most prominent; the anterior costa leads downwards into a kind of cingulum, bordering the anterior edge of the tooth; a deep channel, not extending to the base of the crown, divides the anterior from the posterior lobe of the inner surface.

The inner surface of the hinder lobe has likewise its highest point on the middle line, but there is only a very slight costa on this line; the posterior angle shows the extremity of the central enamel fold of the crown, forming a fissure on the inner surface of the tooth.

At the base of the internal surface of the molars the rugosity of the enamel has almost disappeared; higher up this rugosity reappears, but it is nowhere so much developed as on the outer surface.

The jaw is slender, arcuated, and tapering; the alveoli for the teeth are wide, the jaw contracting suddenly in width below the alveoli. The dimensions of the specimen are as follows:—

	In.
Length of fragment	4·8
Depth of jaw	1·9
Thickness of jaw	1·5
Length of two molars	3·8
Ditto of second molar	1·45
Width of ditto ditto	1·0

The specimen is distinguished from the molars of *Sivatherium,* not only by its very much smaller size, but also by the peculiar form of the inner border of the crown surface, and by the presence of the cingulum and the tubercle at the entrance to the median valley.

The molars approach nearest in form to those of *Camelopardalis,* which they resemble in the obliquity of their position in the jaw, and in the prominence on the inner border of the crown of the postero-internal angles of the barrels: they, however, differ from the molars of *Camelopardalis* by the presence of the cingulum, and by the presence of the large pointed tubercle at the entrance to the median valley in both the molars; the molars of *Camelopardalis* have no cingulum, and the first molar only has a small and blunt tubercle at the entrance to the median valley. The costæ on the inner side of the teeth have the same form in both the genera. The molars of the present form are nearly half-an-inch longer than those of any described species of *Camelopardalis,* and their enamel is much more corrugated. The depth of the present jaw at the second molar is half-an-inch greater than in *Camelopardalis giraffa,* but the jaw is of a more slender type than in the latter genus; in *C. giraffa,* and *C. sivalensis,* the depth of the jaw at the second molar is equal to the length of the second molar plus the length of the hinder barrel of the first molar; in the present specimen the corresponding tooth is one-third of an inch longer than the depth of the jaw at the same point.

The molars are distinguished from those of *Bramatherium* by their smaller size, by the presence of the cingulum and accessory tubercle, and by being placed more obliquely in the jaw.

Till the cranium be discovered, it is difficult to say whether this extinct form of *Ruminant* was most nearly allied to *Sivatherium* or to *Camelopardalis;* the proportions and curve of the jaw are most like those of the former genus, and the teeth are intermediate in size and form between those of both genera. The jaw is somewhat more slender than that of the Siwalik *C. giraffa,* and thereby approaches to the living species of the genus.

Genus Camelopardalis.

Fossils of this genus have been described from the Siwaliks of India, from Perim Island, from the Upper Miocene of Attica (*see Compt. Rendus, vol. LII,*

p. 1295) and doubtfully from France (*see Gervais, "Paléontologie et Zoologie Francaises, p.* 148). My reasons for doubting the validity of Falconer's second Siwalik species will be found in the Records of the Geological Survey of India (vol. IX, pt. 3).

CAMELOPARDALIS SIVALENSIS, *Falc. et nobis*, Plate 7, figs. 14 and 15.

The three lower molars of this species, as extended by me, which are figured in the accompanying plate, were found by Mr. Theobald in the Siwaliks of the Potwar district; the two teeth implanted in a fragment of the jaw are the first and second permanent molars of the right mandible; they are considerably worn, and somewhat imperfect, but they are important, because the corresponding teeth have never been figured as described, and the first of the two is a very characteristic tooth in the living *C. giraffa.* The detached tooth is the ultimate premolar belonging to the same lower jaw; a less worn specimen of the corresponding tooth of the opposite side is figured in the "Palæontological Memoirs" (vol. I, Pl. 16, fig. 78) under the name of *C. affinis.*

The molar teeth are implanted in the jaw in the same oblique manner as in the existing species; the enamel islands in the first molar have been almost obliterated by wear, showing that the animal had nearly attained its full age; in the second molar the posterior fold of enamel is completely insulated, but the anterior fold is still connected with the median infolding of the crown; the condition of these enamel folds in the second molar shows that the Siwalik species had the same peculiarity as the living African species, in which the molars are distinguished from those of all other living *Ruminants* by the late period of life at which the enamel folds of the crown became completely insulated.

The inner wall of the anterior barrel of the second molar is, unfortunately, the only portion of this surface of the teeth which remains complete; in this portion the postero-internal angle forms the most prominent point on the inner border of the crown, while the antero-internal angle is the least prominent of the three ridges into which the side of the barrel is divided, precisely the same as in the molars of the living species.

In the middle of the entrance to the median valley in the first molar, there is a large blunt accessory tubercle (the dentine of which is exposed by wear); in the second molar there is no corresponding tubercle in the median valley; and on turning to Falconer's figure of the ultimate lower molar of this species ("*Pal. Mem., vol. I, pl.* 16, *fig.* 7) no corresponding tubercle is found in the valley of that tooth. We are therefore assured that in *C. sivalensis* the only one of the lower molars provided with an accessory tubercle is the first; in the recent *C. giraffa,* and in no other living *Ruminant,* precisely the same condition occurs in the lower molars, this instance indicates the permanency of apparently unimportant dental characters throughout long periods of time, and in widely separated localities, and affords an

additional argument, if one be needed, of the value of the characters of the molar teeth in determining the affinities of Fossil Mammalia.

The enamel is slightly more rugose than in the living species; the dimensions of the present specimen are given in the first column of the following table, and those of the corresponding parts of the living species in the second column:—

	In.	In.
Length of fragment	4·3	
Depth of jaw at second molar	2·4	1·7
Ditto at first ditto	2·2	1·65
Thickness of jaw	1·2	1·1
Length of first molar	1·3	1·0
Breadth of ditto	1·0	0·9
Length of second molar	1·25	1·15
Breadth of ditto	1·0	0·9

From the above table of measurements it will be seen that the jaw of the fossil Indian species is three-quarters of an inch deeper than that of the living African species, and slightly thicker, while the molars are also of a slightly larger size. The greater stoutness of the fossil jaw perhaps indicates an animal with a shorter and stouter-formed head, approaching in form to the *Sivatherium.*

The right premolar drawn in figure 14 is rather larger than the corresponding tooth of the African *C. giraffa;* both the enamel folds have become insulated by wear; the valley on the outer side, and the antero-external angle are rather more developed than in the premolar of the living species. The dimensions in the table below are compared with those of the ultimate premolar of the African species; the first column contains the measurement of the fossil tooth:—

	In.	In.
Length	1·15	0·9
Breadth...	0·9	0·8

The fossil specimen is, therefore, more oblong than the recent specimen, thereby exhibiting a more generalised type, as the almost square premolar of the African *C. giraffa* is a very unusual character among *Ruminants.*

Genus Bramatherium.

This genus was only known to Falconer by a single species from the one locality of Perim Island. Upper molars of the genus have been described and figured by Falconer ("*Pal. Mem.*," *vol. I, p.* 399) and shown to be very closely allied to those of *Camelopardalis:* the lower molars have not hitherto been figured, and are now for the first time described.

BRAMATHERIUM PERIMENSE, *Falc.*, Plate 7, fig. 13.

The specimen drawn in the above figure is a portion of the right ramus of the mandible, containing the first and second molars, the latter of which is broken on the inner side; the specimen is in the collection of the Asiatic Society of Bengal. The teeth are well worn, although the enamel folds still extend completely across the crown, exhibiting the same lateness in their time of insulation which characterizes the molars of *Camelopardalis.*

The crowns of the molars are of a more "hysodont" type than those of *Camelopardalis,* while the inclination of their long axis to that of the jaw is somewhat more. The postero-internal angles of both barrels form the most prominent points on the inner border of the crown surface, while their antero-internal angles are the least prominent. The outline of the outer half of the crown surface of the hinder barrel forms a triangle with curvilinear boundaries, and the postero-external angle of this portion of the crown surface is produced inwards, to appear as a sharp point on the inner surface of the teeth, between the first and second molars; both of the above characters are also common to the molars of *Camelopardalis.*

On the inner surface the dorsum of the molars is divided into two equal portions, placed parallel to one another, but obliquely to the long axis of the jaw; each of these segments is terminated by a median pointed summit, and is divided by three slight nearly vertical costæ.

On their outer surfaces the teeth are covered by a rugose enamel; on the inner surface the enamel is almost smooth.

The lower molars are distinguished from those of *Camelopardalis* by the crown surface wearing less obliquely, and by the absence of the accessary tubercle at the entrance to the median valley of the first molar; they are also larger in size.

The distinctions between the molars of this genus and those of *Vishnutherium* have been already pointed out.

There appears to be no difference, except that of size, between the lower molars of this genus and those of *Sivatherium;* the upper molars of the two genera have, however, several points of difference (*see* "*Pal. Mem.,*" *vol.* I, *p.* 399). In the above-mentioned note on this genus, Falconer says that the premolars of this genus are distinguished from those of *Camelopardalis,* by the fact that the premolars of the latter genus are characterized by "their great excess of width compared with their length;" in the description, however, of the premolar of *Camelopardalis sivalensis* given above, it was noticed that the squareness of crown characteristic of the living species does not hold in the fossil species; and that, therefore, the form of the crown of the premolar of the latter is the same as in *Bramatherium.* This fact points to the very close connection between the Siwalik forms of the two genera; the long neck and the square-crowned premolar of the living *C. giraffa* being only a recently-acquired character.

The jaw is very thick at the molar alveoli; it is curved along the inferior border, and is much deeper than the jaw of *Camelopardalis giraffa*, but only slightly deeper than that of *C. sivalensis*. The measurements of the specimen are given below in the first column, and the corresponding measurements of *C. giraffa* in the second column:—

	In.	In.
Length of fragment	6·0	...
Length of first molar	1·35	1·0
Width of ditto	1·0	0·9
Length of anterior barrel of second molar	0·8	0·6
Depth of jaw at second molar	2·2	1·6
Thickness of ditto at ditto	1·5	1·0

CAMELUS SIVALENSIS, *Falconer*.

The skull and upper molars of this species have been shortly described by Falconer ("*Pal. Mem.*," *vol. I, p.* 231) and shown to be close in general structure to those of the living camel.

The upper molars, indeed, of the fossil species, seem to be almost indistinguishable from those of the living species, except by being slightly smaller in size. The lower molars, however, of *Camelus sivalensis*, although exhibiting the same simplicity of structure which characterizes the teeth of the family, are readily distinguished from those of the living species.

The inner surface of the lower molars of the fossil species is divided into two equal halves by a median vertical ridge or costa; this ridge is somewhat depressed below the general surface of the wall of the tooth, and has a narrow groove on either side; slight oblique ridges bound the anterior and posterior sides of this surface.

In the living camel, on the other hand, the inner surface of the lower molars is divided into two portions by a very shallow and broad groove, without any trace of the median ridge; the anterior and posterior bounding ridges are also much less strongly marked than in the fossil species, so that the whole of the inner surface of the tooth is nearly flat.

At the antero-external angle of the first barrel of the lower molars of *Camelus sivalensis* there is a prominent vertical ridge, not found in the teeth of the living species. This ridge may be seen in the figure of the lower molars of the Siwalik camel given in the "Fauna Antiqua Sivalensis," (*Plate* 87, *fig.* 5); a similar ridge occurs in the lower molars of the American *Auchenia* (Owen's "*Odontography*," *vol. I, p.* 586), by which they are distinguished from those of the old-world camels. The slenderness of the jaw of the Siwalik camel is also an approach to the form of that of *Auchenia;* none of the specimens of the fossil species exhibit the relationship of the premaxillæ to the nasals; it will be interesting to note, if more perfect specimens subsequently are found, whether the premaxillæ were separated

from the nasals by the maxillæ, as in the living camel, or whether they reached up to them as in *Auchenia*. The discovery of an important dental character common to two such remote forms as *C. sivalensis* and the American *Auchenias* is very interesting, and affords proof of the common origin of the two genera.

Genus Dorcatherium, *Kaup*.

The genus was originally described from the miocene strata of Eppelsheim by Professor Kaup; the skull was furnished with long curved canines, and with bony peduncles for the antlers, in both of which characters it agrees with the living Muntjac of India, which may have been descended from the older form; the cingulated molars of *Dorcatherium* are, however, quite peculiar.

From the Siwaliks, specimens of the molar teeth were obtained by Falconer, and in a manuscript note the specific name of *D. moschinum* was assigned to these remains; no figures or descriptions were, however, ever published, and so it is impossible to know to which of the forms noticed below the name was originally intended to apply. For this reason I have discarded the manuscript specific name and substituted new ones of my own.

Specimens of the molar teeth of this genus have been obtained from Kushalghar, near Attock, from the Siwaliks of the Potwar district by Mr. Theobald, and from the Manchhar beds of Sind by Mr. Fedden.

The teeth from these districts are at once seen to belong to two species,—a larger and a smaller; besides this marked difference, other smaller varieties are noticeable in the specimens from the different localities; these varieties are very probably of specific value, but for the present I have thought it better to describe all the specimens under two specific heads till more complete specimens shall render further specific distinction necessary.

Dorcatherium majus, *n. sp.*, *nobis*, *var. a.—Kushalghar near Attock*, Plate 7, figs. 9, 10, 11.

The two specimens from the above locality are those upon which Dr. Falconer, by some unaccountable oversight, founded the second species of *Merycopotamus* (M. *nanus*) (*see* "*Pal. Mem.*," *vol. I, p.* 416). The larger of the two (*figs.* 9 *and* 10) is the last upper molar of the right side; it is untouched by wear, with the exception of the summit of the outer half of the anterior barrel; the tooth is complete, with the exception of the posterior half of the cingulum, which has been broken away.

The tooth has a nearly square base; the whole of the inner half is surrounded by a deep and projecting cingulum, which forms a small tubercle at the entrance to the median valley; the inner extremities of the barrels are blunt and rounded,

rising nearly vertically from base to summit. The central infoldings of enamel extend deeply into the crown, so that it would not be until a late period that they would become complete islands; the anterior and posterior walls of the central enamel fold of the first barrel are curved round towards the anterior side of the tooth: the summits of the outer halves of the barrels are bent over towards the inner side.

On the external surface (*fig.* 10) the tooth is divided into two unequal and unsymmetrical portions by a vertical groove; the posterior lobe of this surface has a large median ridge curving slightly forwards, as it passes downwards to form the summit of this part of the tooth; on either side of the lateral borders of this lobe there are other still more prominent costæ, the posterior one of which is of great breadth, reflected towards the central costa, and produced into a sharp angle beyond the side of the tooth; neither of these costæ extend downwards to the free edge of the external surface. The anterior lobe (*on the right side of the figure*) has one very prominent median costa, and a shorter and wider anterior costa which embraces the antero-external angle of the crown. The outer half of the hinder barrel slightly overlaps the fore barrel.

Except in its much greater size (*larger than that of any of the European species*) the tooth closely resembles the corresponding molar of *Dorcatherium elegans* of Kaup; the costæ on the outer surface are, however, more developed, and the cingulum more prominent in the Indian form. The dimensions of the two molars are given below; those of the European species in the second column:—

	In.	In.
Length	0·75	0·45
Width at first barrel	0·8	0·55
Height of crown	0·6	0·3

The second tooth from this locality (*fig.* 11) is also an upper molar of the right side; it is somewhat smaller in size than the last specimen, and is worn down nearly to the level of the cingulum. On the external border (*top line of figure*) the boundary of the anterior barrel runs parallel with the long axis of the tooth; the outer surface of this barrel is marked by two costæ, one in the middle, and the other at the anterior angle. The external border of the hinder barrel (*left of figure*) is set obliquely to the long axis of the tooth; the outer surface of this barrel is marked by three costæ.

The cingulum occupies half the circumference of the tooth; it is much shallower, and more closely applied to the surface of the barrels than in the first specimen; along the whole of the inner surface of the anterior barrel the edge of the cingulum is raised into points and casps, and there are two distinct tubercles at the entrance into the median valley. Both this and the preceding specimen are covered with a finely rugose enamel.

This specimen differs from the last chiefly by the smaller size of the cingulum, and its cuspidated character; the difference may, perhaps, not be more than an individual variety. The dimensions of the specimen are as follows :—

	In.
Length	0·6
Width	0·8

Variety b—from the Siwaliks of the Potwar.

The specimen of this variety consists of a portion of a left upper jaw (*Plate* 7, *figs.* 4 *and* 6) containing the second and third molars. On the inner side the teeth differ from the Attock form only by the cingulum being more closely applied to the surface of the barrels.

On the outer surface (*fig.* 6) there is a considerable difference in the two forms. The Siwalik has much simpler and slighter costæ than the Attock form; on the posterior lobe (*right side of fig.* 6) the hind costa is a very slight and simple ridge, without any reflection, totally different from the broad reflected costæ of the Attock form (*left side of fig.* 9); the anterior costæ on both lobes are also much simpler in the Attock than in the Potwar form. The size of the two forms is very similar. Till specimens of the crania are obtained, it is impossible to say whether these differences indicate more than individual varieties; all the specimens from the Potwar, however, in the Indian Museum are similar to those figured.

Dorcatherium minus, *Nov. Sp. nobis, Siwaliks.*—Plate 7, figs 3 and 7.

This species chiefly differs from the preceding by the much smaller size of the teeth; we have specimens in the Indian Museum showing both the molar and premolar series, so the smaller size of the teeth cannot be due to their being the milk-molar series of *D. majus.* The specimens figured are the penultimate and ultimate molars of the right side of the upper jaw. The teeth present the same general form as those of the larger species from the Siwaliks; the costæ are, however, rather less prominent :—

	In.
Length of two molars	0·8
Length of last molar	0·45
Width of last molar	0·4

Genus Cervus.

Of this genus Falconer announced the discovery of two species from the Siwaliks ("*Pal. Mem.,*" *vol.* I, *p.* 23), but these were never named or described, and I am not aware on what materials the species were founded. In the Indian

Museum we have a very large collection of the molar teeth of the genus, and a few broken fragments of antlers, but no crania; from the characters of these upper molar teeth alone I have determined three species of *Cervus* from the Siwaliks, and I think, from the occurrence of some lower jaws which I cannot make to correspond with any of the above, that very probably one or more additional species existed. From the absence of crania and the fragmentary condition of the antlers, the molar teeth afford the only grounds for the determination of the different species. The distinctions between these teeth may at first sight seem to be too slight and trivial for affording specific distinctions; but we must recollect that the molars of all *Ruminants* are formed upon such a similar general plan that variations, which in the teeth of other orders would be considered of only specific value, in this order rank as generic distinctions. The slight variations which do distinguish the teeth of one species of living *Cervus* from those of another are always found to be constant, and therefore of high value in distinguishing between the different species.

In writing of the molars of fossil species of European Deer, Professor Lartet remarks (*Compt. Rend.* 1868, *p.* 1119) that the older forms have short-crowned (brachydont) molars with the depressions on the surface so shallow that the bottom is always visible; while in the recent, pleistocene, and newer tertiary forms, the crowns of the molars are longer (hysodont) and the cavities so deep that the bottom can never be seen in any state of wear. The teeth of the Siwalik *Dorcatherium* belong to the former division; while those of the Siwalik *C. latidens* (infra) are intermediate between the two, the crown being moderately high and the bottom of the cavity visible when half worn : the teeth of the other two species of Siwalik *Cervus* belong to the second type. The teeth of the Siwalik *Cervidæ* therefore indicate that the fauna of these beds is intermediate between that of the miocene and the upper tertiaries of Europe.

From the fragments of antlers which we possess in the Indian Museum, I find that all the species of Siwalik and Narbudda Stags belong to the *Rucervine* division of the group. All the specimens described below were collected by Mr. Theobald, and the majority of them from the Siwaliks of the Potwar district: in this district it appears that *Cervus* was the most common genus of *Mammals* in Siwalik times, whereas in the Sutlej district it was comparatively rare; *Elephants* seem to have been rare in the Potwar district, and abundant in the Sutlej district.

Cervus latidens, *n. sp. nobis.*—Plate 8, figs. 7 and 10.

The present species was the largest of the Siwalik *Cervidæ*, its teeth equalling in size those of the English *Megaceros.* The specimen drawn in figure 10 is the last upper molar of the right side; it is complete and about one-third worn down: the form of the dorsum of these teeth differs somewhat from those of other species of *Cervus*, but for the present, at least, I retain them in that genus.

The crown of the tooth is somewhat oblong in shape, with a produced postero-external angle. On the inner side the anterior barrel projects more inwardly than the posterior barrel. The central enamel folds are large and very deep, the posterior one has no infold from the hinder side; they have just become insulated by wear. In the valley between the two barrels, there is a long and slender accessory column, the summit of which is slightly touched by wear; it is quite distinct from the general dentine surface of the crown.

The outer wall of the fore barrel is parallel to the long axis of the crown; that of the hind barrel is set obliquely; on the outer surface (*fig.* 7) the hind lobe presents two conspicuous lateral costæ, the posterior of which forms an angle beyond the posterior surface; between these two there is a slight trace of a central costa; the fore lobe shows two costæ, one median, and one at the anterior border, the latter produced into an angle; the costæ on both lobes run perpendicularly to the base of the tooth; the outer surface of the hind lobe becomes wider as it approaches the base of the tooth; the lobes on this surface have a general flat appearance. The dimensions of this specimen are—

	In.
Length	1·23
Width	1·0

The peculiar flatness of the external surface, and the want of parallelism of the outer surfaces of the two lobes, together with the presence of the large accessory column, distinguish this tooth from the molars of any living species of *Cervus* with which I am acquainted: the great production of the postero-external angle is also a very peculiar character of the specimen. In no living genera of *Cervidæ* does the accessory column rise to such a height as in this and the succeeding species.* This column is absent in *Tarandus* and *Dama;* short and rudimentary in *Megaceros, Alces* and *Cervus;* slightly taller, but very thin, in *Rusa, Rucervus* and *Panolia;* and tallest and thickest of all in the Siwalik and Rhine *Cervidæ.*

The slight elevation of the costæ on the dorsum, and general squareness of this surface, distinguish this tooth from those of the typical Stags. This flatness, together with the distinctness of the accessory column from the barrels, and the absence of any infold on the posterior side of the hinder enamel island, distinguish this tooth from those of the *Oxen,* and of *Hemibos* and *Amphibos*; it is also distinguished by being shorter, and by rapidly narrowing from base to summit. In all the above genera the dentine surface of the column becomes united with the general dentine surface of the crown, whereas in *Cervus* it remains distinct.

The large lower molar of a species of *Cervus* figured in plate 8, figs. 4 and 6, may, I think, have belonged to an individual of the same species as the above tooth, with which it corresponds in size.

The tooth is from the right ramus of the mandible, and is probably the second true molar; it is distinguished from the lower molars of any recent Stag by the

* *Cervus giganteus* of the Rhine diluvium has a similarly large accessory column.

great height of the crown, and by the peculiar arrangement of the flutings on the inner surface (*fig.* 4), as well as by the great size of the accessory column.

Both of the central enamel folds of the crown have become completely insulated by wear; the inner border of the crown surface (*upper border of fig.* 6) forms a continuous wavy line; the median summits of the inner surfaces of the barrels form the most prominent points on the inner border of the crown surface. The accessory column extends two-thirds up the crown, and is of large relative size, and placed somewhat internally to the mouth of the median valley.

On the external surfaces the enamel is slightly rugose: on the internal surface the enamel is generally smooth, marked here and there by dots and pits. The length of the specimen is 1·1 inches, and the width 0·8 inch; the height of the crown being 1·2 inches.

CERVUS TRIPLIDENS, *nov. sp. nobis.* Plate 8, figs. 1, 2, 5.

This species from the Siwaliks is named from the unusually large size of the accessory column of the upper molars. The specimens figured consist of the second and third molars of the right maxilla; the first of these is slightly worn, while the second is merely a germ, as yet untouched by wear.

The teeth are noticeable for the great elevation of the crown, which is considerably higher than in most living species of *Deer;* the base of each tooth has its antero-posterior diameter rather longer than the transverse. The inner surfaces of the barrels are broad and rounded, sloping slightly from the inner to the outer side; a vertical groove runs down the inner half of the posterior side of the hind barrel. Between the barrels there is a tall and large accessory column extending two-thirds up the crown; the accessory column presents a triangular cross-section, and has a deep vertical groove on its anterior face; the innermost edge of this column projects on the inner side of the tooth in advance of either of the barrels. On the anterior surface of the tooth there is a very small rudiment of a cingulum (*not seen in figure*); these two last characters are constant in all our specimens.

The central enamel-folds on the crown-surface are narrow and shallow, and would become completely insulated at an early period of wear. The innermost dentine surfaces are unsymmetrical and elongated. The outer segments of the barrels are set slightly obliquely to the antero-posterior axis of the tooth, their anterior costæ forming the most prominent points on the outer border of the crown.

On the external surface (*fig.* 2) the hinder barrel is divided into three very prominent costæ; the median costa is by far the larger of the three, and becomes confluent at its base with the other two; as it descends from the neck of the tooth, it rapidly diminishes in width and bends slightly forwards: deep grooves divide the costæ. The external lobe of each barrel becomes narrower as it ascends from the summit of the crown to the neck. The posterior barrel shows only two costæ

on its external surface, the anterior of which is the larger. A rugose enamel covers the whole of the teeth : the dimensions are as follows :—

	In.
Length of two molars	1·8
Length of second molar	0·8
Width of ditto	0·95
Height of ditto	1·1
Width of third molar	1·0
Height of ditto	1·25

Other specimens in the Museum are slightly larger.

The upper molars of the present species are distinguished from those of the preceding by the absence of the produced postero-external angle; by the presence of the prominent costæ and grooves; by the outer surface of the lobes becoming narrower at the base instead of wider; by the presence of the small cingulum on the anterior surface; and by the presence of the groove on the accessory column.

The tall accessory column distinguishes the teeth from those of the European *Deer*.

From the Indian *Rusa* and *Rucervus*, the present teeth are distinguished by the antero-posterior diameter being longer and the transverse diameter shorter: by the greater height of the crown; by the larger size of the accessory column; and by the larger size and curving of the median costæ on the outer surfaces of the lobes.

The lower molars figured in plate 8, fig. 5, may, I think, possibly belong to this species; the specimen contains the two last molars of the right side: both of them are complete, and in an excellent state of preservation.

The ultimate molar, as usual, is composed of three barrels, the last of which is of relatively large size, though still smaller than either of the anterior barrels; the inner boundary of the crown runs parallel to the long axis of the tooth, so that in the barrels the median costa becomes the most prominent point along the whole inner border of the tooth. The external surfaces of the tooth are bluntly rounded off and rise almost vertically from the neck to the summit of the crown; the median valley between the barrels extends far into the centre of the crown; at the base of the entrance into the external valley there is a very small accessory tubercle. The central enamel-folds are completely insulated by wear; the folds are of large size, constructed in the middle and swelling out at either end. At the antero-external angle of the first barrel there is a loop formed in the enamel, and a consequent ridge and groove at this part of the external surface of the tooth; the anterior boundary of the crown-surface runs at right angles to the long axis of the tooth. The third lobe is connected by a narrow isthmus with the second.

On the inner surface the barrels are separated from each other by a deep vertical groove: the anterior barrel has a very prominent median costa, and a faintly marked costa on either side; the second lobe has the prominent and tall median costa,

and a second costa on the posterior border only: the third lobe has no distinct costa.

The first molar is similar to the first two lobes of the last tooth. The whole of the surface of the teeth is coated with a finely rugose enamel, something like that of *Camelopardalis*. The teeth are considerably larger than those of the *Sambar*, with which their measurements are compared below; those of the *Sambar* being in the second column :—

	In.	In.
Length of last molar	1·4	1·25
Length of penultimate molar	1·0	0·9
Width of ditto	0·7	0·6

The teeth are distinguished from those of the *Sambar* and *Barasingha* by their outer surface being perfectly parallel to their long axis, instead of each barrel being set slightly obliquely to this: they are further distinguished by the very small size of the accessory tubercles and by the roughness of the enamel.

The parallelism of the outer surface to the long axis of the tooth is a character these teeth possess in common with *Cervus elephas* of Europe, from which they are distinguished by the bluntness of the inner surfaces of the barrels, the small accessory tubercles, and the prominent ridge at the antero-external angle.

It is only in regard to size that these lower molars agree with the upper molars of *C. triplidens;* the absence in the lower molars of the accessory column is a great point of difference, and they may eventually have to be referred to a fourth species of Siwalik *Cervus.*

CERVUS SIMPLICIDENS, *nov. sp. nobis.* Plate 8, fig. 3.

This third species of Siwalik *Cervus* is founded upon another type of upper molars, of which two are given in the above figure. These teeth are the last two molars of the left side, and have but just been touched by wear. The general form of the teeth is very near to those of the living *Rucervus duvaucellii,* and very different from those of both the species described above. The crowns are tall and somewhat slender, the inner surfaces sloping away from the inner to the outer side. The outer surfaces of both barrels are set nearly parallel to the antero-posterior axis of the crown; the antero-external angle of each barrel being the most prominent points on the outer border, but neither of them more prominent than the other. The innermost summits of the barrels are extended antero-posteriorly.

The median valley on the inner side extends for a long distance between the barrels; at the entrance to this valley there is a very small accessory tubercle, less than a quarter of an inch in height, and never forming a part of the worn-crown surface; it is placed in the valley considerably further in than the bases of the barrels.

On the anterior and posterior surfaces of the teeth there is a semi-vertical fold or ridge of enamel, looking like the commencement of a cingulum; on the external surface the form of the teeth is similar to that of the tooth of *Cervus triplidens* described above. The enamel is slightly rugose. The measurements of the specimen are given below :—

	In.
Length of two molars	1·7
Length of last molar	0·9
Width of ditto	0·9

The teeth are distinguished from those of *Cervus triplidens* by the small size of the accessory tubercle and its position far within the median valley, by the squareness of the crown, and by the smaller obliquity of the external halves of the barrels to the antero-posterior axis of the tooth.

The present molars approach somewhat in general form to those of the living *Rucervus duvaucellii;* they are, however, distinguished by the smaller degree of obliquity of the outer surfaces of the barrels to one another, and to the antero-posterior axis of the tooth; they are also distinguished by the presence of the enamel folds on the anterior and posterior surfaces.

Genus Listriodon, *H. von Meyer.*

The occurrence of this genus in the Indian Tertiaries was first announced by me in my paper on Indian Fossil Mammalia ("*Rec. Geol. Surv., Ind., vol. IX, pt.* 3); the specimens on which this identification was made are now for the first time figured and described; the genus was originally founded on specimens of the molars from the Molasse of Switzerland; a description of these teeth is given in Dunker's "Palæontographica" (1874, *page* 208, *and plate VII, fig.* 71). The first of the Indian specimens is the same as that referred by Falconer to the genus *Tapirus* ("*Pal. Mem.,*" *vol. I, p.* 415), and to which he assigned the name of *Tapirus pentapotamiœ:* on the authority of this specimen the genus *Tapirus* is introduced by Mr. Wallace among the Fossil Siwalik Mammalia.*

The second specimen was brought from the Siwaliks of the Panjab by Mr. Theobald, and was, from its similarity to Falconer's wrongly-named specimen, at first referred by me to *Tapirus.* The only fossil from India that has been described as *Tapirus,* besides the above, is a portion of the symphysis of a mandible from Burma (*Clift:* "*Trans. Geol. Soc., Lon.,*" *Sec. Ser., vol. II*); this may very probably have belonged to the present genus.

Listriodon pentapotamiæ, *Falc. sp.* Pl. 8, figs. 8, 9.

The first of the two specimens (*fig.* 8) is the above-mentioned specimen of Falconer's (now in the Indian Museum) from the Tertiary beds of Kúshalghar near

* Distribution of Animals, vol. I, p. 122.

Attock. The specimen is from the right side of the upper jaw, and is either the second or third true molar. The crown of the tooth is nearly square; the summits of the ridges are slightly abraded by oblique surfaces of wear, and there is a disc of pressure on both fore and hinder surfaces.

The crown is raised into two parallel transverse ridges of nearly equal size; these ridges are separated by a deep intervening valley, which extends completely across the tooth, and which slopes on the outer side quite down to the base, without any trace of a longitudinal wall connecting the two ridges. The posterior surfaces of the ridges are concave, and the anterior ridges slightly convex; the worn surfaces on their summits slope towards the anterior extremity of the tooth. From the internal summit of the anterior ridge a wide ledge curves across the anterior surface of the tooth to the internal extremity of the ridge; a smaller and nearly horizontal ledge joins the former at the antero-internal angle of the crown; another waving and slightly cuspidate ledge, bounding a hollow, runs along the whole of the posterior surface of the tooth, and there is a small and blunted tubercle at both extremities of the median transverse valley; these ledges and tubercles may be considered as an incomplete cingulum. The measurements of the specimen are as follows:—

	In.
Length	0·82
Width of anterior surface	0·80
Ditto of posterior ditto	0·80

The form of the tooth, as pointed out by H. von Meyer, differs from that of *Tapirus* and *Lophiodon*, in that the transverse valley extends completely across the crown, and that, consequently, the longitudinal outer wall connecting the transverse ridges of the molars of the latter genera is wanting. The teeth, were it not for their square form, might be mistaken for the lower molars of *Tapirus;* they are of the simplest form of structure that occurs in any genus of this group of Mammalia. In certain upper molars of *Lophiodon*, figured by De Blainville (*Osteographie Atlas vol. IV, plate Chæropotamus*), the longitudinal outer wall is nearly absent, and the teeth ought, perhaps, to be referred to the present genus.

The tooth differs from the upper molar of *Listriodon* from the Swiss Molasse, in that the ledges or cingula are not crenulated, and that the anterior of these is confined to the anterior surface, and does not extend round the outer extremity of the ridge to the median valley as in the European form.

The upper molars of this genus resemble in form the upper molars of *Dinotherium*, while those of *Tapirus* resemble the premolars of *Dinotherium;* the latter genus is remarkable for having its premolars more complex than its molars; the lower molars of *Listriodon* are very like those of *Tapirus.*

The teeth of this genus may be considered as transitional forms between the *bunodont* type of *Tetracondon* (infra) and the *lophodont* type of *Tapirus;* in the present genus the two pairs of outer and inner cones of the tetraconodont form are

connected by transverse ridges, while in *Tapirus* and its allies, the two outer cones are also connected by a longitudinal ridge. In this manner a transition is effected from the simple *bunodont* form through the *lophodont* to the *selonadont* type of the Ruminants.

The second upper molar of this species figured (*fig.* 9) is from the Potwar district of the Panjab; like the preceding specimen, this also is from the right maxilla; the form of the two teeth is similar, but the present specimen is rather the smaller of the two; its dimensions are as follows:—

	In.
Length	0·81
Width at anterior end	0·75
Ditto posterior end	0·74

GENUS DINOTHERIUM, *Kaup.*

This genus was first introduced to the Indian Fossil Fauna by Falconer from a specimen of a portion of a first lower molar and of a lower jaw discovered in Perim Island ("*Palæontological Memoirs,*" *vol. I, p.* 396); the species was named by Falconer *Dinotherium indicum.* Subsequently, the same naturalist identified two other molar teeth from near Attock ("*Pal. Mem.,*" *vol. I, p.* 414) as belonging to the same genus; in the note on these specimens in the "Palæontological Memoirs" no specific name was assigned to them, though they were considered to be of too small a size to have belonged to *D.* (*perimense*) *indicum;* these specimens are now in the Indian Museum; they are ticketed with labels in Falconer's handwriting bearing the name of *D. pentapotamiæ,* which name I have accordingly adopted. Other specimens have been obtained by Mr. Fedden from Sind and Kach, and are figured in the present paper. All these specimens seem to belong to the same species, which was much smaller than *D. indicum* or any European form; it is unfortunate that the Perim Island species is only known by the above-mentioned fragmentary tooth and lower jaw, in the latter of which the crowns of the molars have all been broken off, so that comparison between the teeth of that species and of *D. pentapotamiæ* is impossible. In the collection sent to the Asiatic Society of Bengal by Captain Fulljames from Perim, there were certain molar teeth which were conjectured to belong to *Lophiodon:* Dr. Falconer suggested these might also belong to *Dinotherium* ("*Pal. Mem.,*" *vol. I, p.* 397). Unfortunately, I am quite unable to discover what has become of these fossils.

DINOTHERIUM PENTAPOTAMIÆ, *Falc. et nobis*, Pl. 9, figs. 1 to 5.

The first of the Attock specimens (*fig.* 1) noticed by Dr. Falconer is "the penultimate or first premolar, upper jaw, right side; at least this is inferred from its form and an obscure disc of pressure on the posterior side, and from there being

no disc of pressure in front." Dr. Falconer might have added that the present tooth is at once distinguished from the second premolar by the outer ridge not being cleft by a transverse valley, and by the posterior tubercle being separated by a deep longitudinal valley from the outer ridge.

The crown of the tooth is approximately square; the tooth was inserted into the jaw by three fangs, two very large ones at the outer angles, and a smaller one placed on the inner border at the angle between the two former. The outer side of the crown is raised into a longitudinal ridge, rising vertically on the outer side, and sloping gradually on the inner side; the ridge is slightly convex antero-posteriorly; its enamel is rounded off on its summit, but is not cut through by wear. The inner side of the crown has two mammilloid tubercles, of which the anterior is the larger and higher; the enamel of the latter is slightly cut through by wear; the posterior tubercle is only rounded off; a wide longitudinal valley, which is deepest at the posterior extremity, divides the two tubercles from the outer ridge; the transverse valley between the tubercles is very narrow. The cingulum surrounds three sides of the crown; it is entirely wanting on the outer side; its margin is irregularly crenulated; it is much the widest on the anterior side; on the inner side it becomes very slight on the surfaces of the tubercles; between the tubercles it forms a cleft ridge blocking the entrance to the transverse valley.

The specimen is distinguished by its much smaller size from any of the European species; from the first premolar of *D. giganteum* and *D. cuvieri,* it is distinguished by the following points: the antero-posterior valley is very much deeper and wider in the Indian form, rendering thereby the inner tubercles more completely conical; the posterior tubercle is mammilliform in the Indian form, whereas it is elongated transversely in the European form; in the latter the cingulum forms a much more regular rim round the three sides of the crown; there is a distinct ledge instead of a mere wavy line on the inner surfaces of the tubercles, and consequently the portion of the cingulum at the entrance to the transverse valley does not project in advance of the rest, as in the Indian form; further, the centre of the outer ridge is slightly hollowed in the European form.

The measurements of the first premolar of *D. giganteum* are compared below with those of the present specimen:—

	European.	Indian.
Antero-posterior diameter, outer edge	3·4	2·3
Ditto ditto inner ditto	2·75	1·6
Transverse diameter	3·1	2·1

The second of the Attock specimens (*fig.* 2) is the first true molar of the right side of the upper jaw; it probably belonged to the same individual as the last specimen; its position in the upper molar series is determined by its possessing three transverse ridges, whereas the succeeding molars are simple, having only two ridges (a very rare condition in the teeth of mammalia); that the specimen belongs to the upper jaw is inferred by its having a cingulum or talon ridge at both ends,

whereas the corresponding molar of the lower jaw has a talon-ridge at the posterior end only.

The crown is oblong, bearing three nearly parallel transverse ridges; the median ridge has been somewhat broken; the two anterior ridges have been considerably worn, and show pyriform dentine surfaces; the large extremity of these surfaces is on the inner side; the hindmost ridge is only slightly touched by wear; the plane of wear slopes obliquely towards the anterior side of the tooth. All the three ridges are concave posteriorly and convex anteriorly; they are raised into prominences at both inner and outer extremities. Along the whole of the anterior side of the tooth, there is a wide talon-ridge or cingulum, with a valley at its hinder border: on the posterior surface of the tooth there is a smaller crenulated cingulum, occupying the concavity of the hindmost ridge: on the inner border of the tooth there is a small tubercle at the entrance to the transverse valley between the first and second ridges; a similar tubercle, when the tooth was perfect, probably occupied the corresponding space in the second valley; there is no trace of any cingulum on the inner surfaces of the ridges. Except in its much smaller size, the form of the tooth is very similar to the first upper molar of *D. giganteum;* the latter, however, has a slight cingulum on its inner surface. Below the dimensions of the Indian and European specimens are compared :—

	European.	Indian.
Antero-posterior diameter	4·1	2·75
Transverse ditto first ridge...	3·2	2·4
Ditto ditto last ditto...	2·65	2·1

Dr. Falconer compared this specimen with the third milk molar of the European species; from its being associated with a premolar, there can, however, be no doubt but that this specimen belongs to the permanent and not to the deciduous series; and therefore that it should be compared with the large permanent first molar of the European series.

The broken specimen (*fig.* 4) is also the first upper molar of the right side; it is from Kach, and is precisely similar to the Attock specimen; the specimen shows the two hinder ridges and the tubercle of the first valley.

The large tooth in the centre of the plate (*fig.* 3) is also from Kach, and was collected by Mr. Fedden; it is the second upper molar of the right side; from its size I make no doubt but that it belonged to the same species as the preceding specimens. The tooth has four fangs; the crown is nearly square and carries two transverse ridges convex anteriorly and concave posteriorly; the anterior ridge has its enamel worn through at both extremities, the posterior ridge has the enamel only obliquely abraded by wear. The median transverse valley is partly blocked at its outer extremity by a low wall connecting the two ridges; at its inner extremity it has a large tubercle, flat internally and convex externally; at the anterior end of the tooth there is a wide cingulum or talon-ridge, raised into prominences at either

end; at the posterior end there is a small cingulum occupying the base of the concavity of the second ridge, and a second smaller prominence below the outer extremity of the same ridge.

Besides its smaller size, the tooth is distinguished from the second molar of *D. giganteum* by the greater concavity of the posterior surface of the second ridge, and by the consequently greater prominence of the cingulum; the tubercle in the median valley is also larger; the anterior cingulum is raised into prominences instead of being level; and the transverse valley is blocked at the outer side instead of being quite free. The dimensions of the two teeth are given below:—

	European.	Indian.
Antero-posterior diameter	3·90	2·70
Transverse diameter of first ridge	3·65	2·45
Ditto ditto of second ditto	3·55	2·30
Greatest height of crown	2·05	1·50

The last specimen (*fig.* 5) is a portion of a first molar of the left ramus of the mandible. The specimen is from Sind, and contains the first and second ridges only, the third having been broken off; its position in the series is determined by its being three-ridged, and it is seen to belong to the lower jaw by the absence of any cingulum at the anterior end. The inner side of the second ridge has the enamel worn through at one spot; the valley between the first and second ridges is very shallow, and deepest at its extremities; the anterior ridge is very short and raised into a tubercle at its centre.

From its small size there can be no doubt but that the tooth belongs to the same species as the previous specimens. The dimensions of this specimen are given below, *viz.*:—

	In.
Length of fragment	2·05
Width of first ridge	1·60
Ditto of second ditto	2·05

The width of the base of the crown of the corresponding molar of the Perim Island jaw is 2·9 inches, showing that the teeth of that species were very considerably larger than the present specimens. A last upper molar, a first lower molar, and fragments of other molars of a species of *Dinotherium* are figured by Professor H. von Meyer in the German "Palæontographica" (*vol. XV, pl.* 3); these specimens were collected by the Messrs. Schlagintweit at Kúshalghar; the teeth correspond in form with the present specimens, and doubtless belonged to the same species; the last upper molar is, as would be expected, rather larger than the penultimate tooth figured here; the lower molar corresponds in size with the present specimens; the cingula in the German specimens are rather more crenulated than in ours.

GENUS SANITHERIUM, *H. von Meyer.*

In my paper on Tertiary Mammals* above quoted this genus was unfortunately omitted from the list of Indian forms; it was provisionally established by Professor von Meyer in 1866 for the reception of some small molar teeth of a Suine animal ("*Palæontographica,*" *vol. XV, p.* 15) collected by the Messrs. Schlagintweit at Kúshalghar. On comparing these figures with the specimen of the lower molar of *Sus pusillus* of Falconer in the Indian Museum, I found the two were identical. Although Falconer's specimen was named in manuscript before 1866, the name was not published till 1868 in the "Palæontological Memoirs." Professor H. von Meyer's specific name (*S. schlagintweitii*), therefore, must stand. I may here add that in the same paper Professor von Meyer has described another species of *Equus* (*E. primigenius*) from the Kúshalghar beds, and from the lower Siwaliks of Nurpúr in Chamba: the species is distinct from either *E. sivalensis*, or *Hippotherium antilopinum;* the existence of this third species, common to European and American tertiaries, is another proof of the distinctness of the Mammalian fauna of these beds, from that of the upper typical Siwaliks of Falconer; the Nurpúr beds from which also *Amphicyon* was derived being at the very base of the Siwaliks.

SANITHERIUM SCHLAGINTWEITII, *H. von Meyer.* Plate 9, figs. 6 to 9.

Of this species I have copied two of Professor Von Meyer's figures ("*Palæontographica,*" *vol. XV, pl. II, figs.* 9, 10) (figs. 6 and 7), and have added two figures of Falconer's specimen (*Sus pusillus*) (figs. 8 and 9). A translation of Professor von Meyer's description of his specimen is as follows:—"The fragment represented belongs to the left ramus of the mandible, and contains a complete tooth, probably the penultimate molar, with the first lobe of the last molar. The former tooth has a length of 0·011 mm., and has its anterior lobe considerably worn down; its greatest width is 0·008 mm. From each of the main tubercles of the transverse ridges of the crown a projection runs down to its postero-internal angle; this projection is well seen on the anterior one of the outer tubercles. Between the transverse ridges there is an accessory tubercle; besides this there is a distinct talon-ridge on both anterior and posterior surfaces, and on the outer surface a crenulated cingulum, while the antero-external main tubercle is connected with the anterior talon-ridge; this condition is well seen on the fragment of the last molar. The animal was about half the size of *Sus hysudricus,* and there is no mention of such an animal in the "Fauna Antiqua Sivalensis," or elsewhere in papers on Asia.

"The teeth remind us of those of *Chæropotamus*, but are smaller; they are also related to those of *Hyracotherium,* and are of nearly the same size; the lower molars of this genus are, however, not known to me; besides, there are other *Suinæ,* such as *Peccari, Babirusa, Hyotherium, &c.,* which, however, have very distinct accessory tubercles, and which lack the crenulated cingulum on the lower molars.

* Rec., Geol. Surv., Ind., vol. ix., pt. 3.

"These fragments may, therefore, be considered as belonging to a new species; to determine the genus with accuracy, these fragments are not sufficient: assuming the genus to be new, I propose the name of *Sanitherium* (*Sani: an Indian goddess*) with the specific name of its discoverers."

The specimen in the Indian Museum (*figs.* 6 *and* 7) from the same locality as the above shows the two hindmost lobes of the last molar of the right side of the mandible; the alveolus of the anterior lobe is also shown. The tooth is very slightly worn; it is constructed on the general type of the teeth of *Suina*, showing a narrow and shallow antero-posterior valley, and deeper transverse valleys, so that the summit of the crown forms transverse ridges divided into tubercles at the outer and inner extremities; there is an irregular accessory tubercle in the centre of the transverse valleys; and the extremities of the main tubercles are irregularly defined; the crenulated cingulum on the inner surface does not extend to the hindmost lobe; the outer tubercle of the first ridge has long projections from each of its internal angles. The plane of wear slopes very obliquely from within outwards; the enamel is slightly wrinkled. The dimensions of the specimen are as follows:—

	In.
Length of last molar	0·68
Width of second ridge	0·31
Probable depth of jaw	0·75

The teeth of this animal are distinguished from those of *Sus* by the greater simplicity and distinctness of the main tubercles, and consequently by the boundaries of the dentine surfaces of the worn-crown being less contorted; by the tubercle in the transverse valley being less distinct and smaller; by the hinder lobe being larger and taller in proportion to the others; by the plane of wear being considerably more oblique; and, lastly, by the presence of the cingulum.

The lower molars of *Hyracotherium* are at once distinguished from the present specimens by their higher tubercles, more open transverse valley, without any central tubercle, and absence of cingulum.

The lower molars of *Chœrotherium* and *Acotherium* have simple conical tubercles with very wide and open valleys, no accessory tubercles, and no continuous cingulum; those of *Hyotherium* have the outer tubercles concave on the inner side, and the inner tubercles simple, and with no cingulum.

The lower molars of *Chœropotamus* also have the outer tubercles concave on their inner side; and the two pairs of tubercles are separated by a much wider and deeper longitudinal valley, so that the worn dentine surfaces would not be united till the crown was nearly completely abraded away: finally, the cingulum is not crenulated, and does not extend on to the anterior lobe.

The lower molars of *Rhagatherium* and *Hyopotamus* have an approach to the form of the teeth of *Ruminants*, and are therefore widely different from the present specimens.

In the living *Peccari* and *Babirusa* the lower molars have no crenulated cingulum, and the third lobe of the last molar is much smaller in proportion to the others than in the present specimens.

From the above comparisons there can, I think, be no doubt as to the validity of Professor Meyer's genus *Sanitherium:* I have not found among our Indian collections any specimens which I can refer to the upper molars of this genus. This genus, with the addition of the next, gives the following list of *Suina* from the Tertiaries of India, a list equal in extent to that of the fossil Proboscidian fauna of India, *viz.* :—

SUIDÆ.

Sus giganteus.	*Hippohyus sivalensis.*
Sus hysudricus.	*Sanitherium Schlagintweitii.*

ANTHRACOTHERIDÆ.

Anthracotherium (*Chœromeryx*) *silistrense.*	*Merycopotamus dissimilis.*

HIPPOPOTAMIDÆ.

Hexaprotodon sivalense.	*Hexaprotodon namadicum.*
Hexaprotodon iravadicum.	*Tetraprotodon palæindicum.*

TETRACONODONTIDÆ.

Tetraconodon magnum.

Hippohyus connects the *Pigs* with *Hippopotamus*, and *Sanitherium* with the *Anthracotheridæ : Merycopotamus* is a link between *Hippopotamus* and *Hyopotamus*, and so joins on with the *Ruminantia;* while *Tetraconodon* presents affinities in its molar teeth with *Anthracotherium,* and diverges from all other genera in its gigantic premolars; it is a difficult question to decide whether *Merycopotamus* should be put into the same family as *Hyopotamus* (*Anthracotheridæ*), with which it is so closely united by the form of the molars, or whether with the *Hippopotamidæ*, with which it is connected by many points of its anatomy, most notably by the peculiar form of the lower jaw. *Tetraconodon* should, I think, without doubt be placed in a distinct family.

GENUS TETRACONODON, *Falconer.*

This genus of *Hippopotamoid Ungulates* was formed by the late Dr. Falconer on the evidence of a portion of a lower jaw containing the ultimate and penultimate molars; the specimen was found by Messrs. Baker and Durand in Siwalik strata between the Markandá Pass and Pinjór; it was figured by them in the "Asiatic Researches" (*vol. XIX, pl.* 5, *fig.* 2); the figure has been copied in the "Palæontological Memoirs" (*vol.* I, *p.* 150, *fig.* 5) to illustrate Dr. Falconer's memoirs on the specimen; in this memoir the specimen is described as being the right upper jaw; this is the more strange, as Dr. Falconer himself says the last tooth is known to be the ultimate molar "by having the accessory spur or process which characterizes this tooth;" this large accessory spur only occurs in the lower molars of the *Ungulata,* to which series the specimen undoubtedly belongs. Falconer's specimen appears to have been lost, and no other specimens have hitherto been known till the discovery of the specimen described below.

The discovery of that specimen fully carries out Falconer's idea of the generic distinctness of the form, although it seems to have been generally neglected by subsequent writers.

TETRACONODON MAGNUM, *Falconer*. Plate 10.

The unique specimen of the greater part of the right ramus of the mandible of this species, of which three views are given in the accompanying plate, has already been shortly described in the "Records of the Geological Survey of India" (*vol. IX, p.* 101), but is now for the first time figured; the present description is mainly copied from the above notice.

The specimen was discovered by Mr. Theobald in the Upper Siwaliks of Asnot in the Panjab; it contains the two last premolars, and the first and second molars; the whole of the penultimate and a portion of the ultimate premolar, together with the first molar of the left side of the mandible, were also found with the specimen, and it is probable that the whole jaw existed in the rock, but was broken up by the native collector in extracting it. The first molar tooth is somewhat broken on its anterior half; the rest of the teeth are complete.

The second molar has only just commenced to be touched by wear on its anterior tubercles; the second premolar has a small dentine surface exposed on its summit; the summit of the first premolar is only blunted; both these teeth have not been protruded to their full height above the jaw; the animal was evidently adolescent at the time of its death.

The crown of the second molar, being the most complete, this tooth is here selected for description; the shape of the crown is oblong, having four conical or mastoid prominences at its angles; a cruciform valley divides these prominences or cones; the transverse portion of this valley is considerably the wider and deeper of the two; the extremities of this transverse valley extend downwards to the base of the crown; in the central hollow between the four cones there is a flat bi-lobed tubercle; a large talon-tubercle occupies the hindmost portion of the antero-posterior valley, while a flatter tubercle occupies the anterior extremity of the same valley; there is a very small and conical tubercle at the outer extremity of the transverse valley. The plane of wear of the molars, as shown on the first molar, slopes slightly towards the outer side; there is no trace of a cingulum on any portion of the molars.

Turning now to the premolar teeth, of which these are the only known specimens in existence, we find them of a most abnormal and interesting character; these teeth are of a considerably larger size than the true molars, a character which is, I believe, unknown among other *Ungulates*, though it occurs in the dental system of *Pteropus*. The premolars are placed in direct contact with the molar series, and in form have a general resemblance to the corresponding teeth of *Hippopotamus*, *Merycopotamus*, and *Anthracotherium*; each tooth is inserted into the jaw by two fangs; the penultimate premolar does not present any disc of pressure

on its anterior surface; this tooth was therefore probably separated by a diastema from the preceding tooth, as in *Hippopotamus*.

The ultimate premolar has a nearly square base, from which rises a simple oblique and compressed cone; the summit of the cone is directed backwards and placed somewhat in advance of the hindmost border of the crown; the anterior face of the cone is produced into a sharp sinuous ridge, which extends from the summit nearly to the base; below this the ridge bifurcates and forms a slight cingulum which extends along the greater part of the base of the anterior surface. A small tubercle is placed between the summit of the cone and the posterior border of the crown; this tubercle forms the summit of a second cingulum which extends across the posterior surface of the tooth; this posterior cingulum slopes from the central tubercle on either side towards the base of the crown; the outer edge of this cingulum forms a very distinct ledge at the postero-external angle of the crown; a rounded notch cuts into the outer and the inner sides of the crown, between the roots of the fangs; the inner surface of the tooth rises nearly vertically from the jaw, while the outer surface slopes considerably towards the inner side. The summit of the cone is worn obliquely, the facet of dentine being directed upwards and backwards; the facet of wear presents two planes, the hinder of which is the most oblique to the axis of the cone; the form of the facet is oval, the long diameter being placed in the line of the jaw. The enamel of the crown is arranged in irregular branching ridges, which radiate from the summit of the cone to the periphery of its base; these ridges are again marked by fine parallel transverse striæ.

The penultimate premolar is somewhat smaller than the last of the series, its base approaches a triangular form, constricted laterally between the fangs, and blunted at the apex; the summit of the cone is placed slightly behind the centre of the crown, and has a prominent ridge running to the base of the crown, on both anterior and posterior surfaces; there is a well-defined cingulum on the posterior surface, which also extends along the hinder half of the internal surface. Like the other premolar, the cone is convex and sloping on the external surface, and nearly vertical on the internal surface; this latter surface is divided by a vertical groove.

The dimensions of this specimen are as follows in inches and tenths:—

Length of two molars	2·50
Ditto second molar	1·45
Width of ditto ditto	1·30
Height of ditto ditto	0·80
Length of ultimate premolar	2·15
Width of ditto ditto	2·10
Height of ditto ditto	1·80
Length of penultimate premolar	2·05
Width of ditto ditto	1·80
Height of ditto ditto	1·65
Depth of jaw at ultimate premolar...	3·10
Length of the fragment	8·00

The dimensions of Falconer's specimen are as follows :—

Length of the fragment	3·38
Ditto of the last molar	2·05
Ditto ditto excluding the spur	1·68
Greatest width of ditto	1·48
Height of posterior cones of last molar	0·75
Length of the anterior molar	1·20
Width of ditto ditto	1·30
Anterior width of top of crown of last molar	1·20

From the two specimens, we are able to say that the dentition of the mandible of this species comprised three true molars, of which the last had a third lobe; in front of these there were two conical premolars, in close opposition; then came a diastema, in front of which there was probably one premolar as in *Anthracotherium,* or two as in *Hippopotamus;* of the canines or incisors we know nothing. I should, however, imagine they were large in size, and that the incisors were probably three in number. Dr. Falconer instituted a careful comparison between the molars of his specimen and those of other genera of *Suina;* he, however, compared them with the upper instead of with the lower molars. Apart from the premolars, which are of themselves amply sufficient to distinguish the genus from all other forms of *Suina,* the lower molars are also very characteristic teeth; they are the simplest teeth of any of the group ; their four simple cones, with the absence of a collection of semi-distinct tubercles, and the slight degree of obliquity of the worn crown, distinguish them from the molars of *Sus.* From the molars of *Hippopotamus* they are distinguished by the worn-dentine surfaces of the cones, being approximately circular in form, and never trefoil-shaped. The lower molars of *Anthracotherium* are distinguished from those of this species by having the inner side of their outer cones concave, thereby approximating to the *Ruminant* type, by having an incomplete cingulum on the outer side, and by the third lobe of the last molar being larger and undivided.

The gigantic size of the premolars of this genus appears to be an extension backwards of the ultra development of the anterior teeth which occurs in *Hippopotamus, Sus, Phacochœrus* and *Babirusa;* in the living genera this ultra development is confined to the canines and incisors, while in the fossil genus it extends to the premolars. The premolars of this species, though formed on the same plan as those of *Hippopotamus* and *Anthracotherium,* are of a more simple type, their summits being more regular cones, without accessary columns, and lacking the complete cingulum which invests the premolars of several species of *Hippopotamus.*

The teeth of this genus belong to a very simple and generalized type; the true molars belong to the typical *bunodont* form of Professor Leidy, while the premolars are single cones of the *trichecodont* form of the same author. The *bunodont* form Professor Leidy regards as the earliest and least specialised type of Mammalian

molars, although, as in man, it is occasionally persistent; the great developement of the premolars of *Tetraconodon* is, of course, a specialised character; by an infolding of the cones of the molars, and by heightening of their crowns, the teeth of *Tetraconodon* could be easily modified into the molars of *Hippopotamus*.

Order: EDENTATA.

GENUS MANIS (PANGOLIN, *Gray*.)

The announcement of the addition of the remains of a species of *Edentata* to the Indian fossil fauna has been already made by me on a previous occasion ("*Rec. Geol. Surv., Ind,*" *vol. IX, p.* 106); the specimen on which this determination was made is now for the first time figured and described. The presence of a representative of this abnormally distributed order in the Tertiaries of India was only what might reasonably have been expected, and affords another proof of the common origin of the Indian and Ethiopian fauna in tertiary times; of the four modern Ethiopian genera, *viz., Struthio, Hippopotamus, Camelopardalis* and *Manis,* which lived in India during the tertiary period, the latter genus is the only one which has survived in that country down to the present day. The genus *Manis* (*and Pangolin*) is now confined to Africa and India; it was represented in Europe during the older Pliocene period by one species (*Pangolin gigantesque,* Cuv., *Macrotherium,* Lartet), which was perhaps subgenerically distinct. Besides the one Indian specimen and the European species, no other fossil forms of the family are known.

MANIS SINDIENSIS, *n. sp. nobis.* Pl. 8, figs. 11 to 14.

The specimen on which the species is founded was collected last season by Mr. Fedden from the Manchhar (Siwalik) beds of Sind; it is the second phalange of the third or middle digit of the manus, and is a very characteristic and unmistakeable bone: four views of the specimen are given in the accompanying plate.

The superior surface of the bone (*fig.* 14) is ovate in form, and is divided by a strong median ridge, which expands at both its extremities, the lateral margins of the surface are also slightly raised, forming elliptical hollows on either side of the median ridge; from this we infer that the distal surface of the first phalange had a large, deeply grooved trochlea. The distal extremity of the bone forms a trochlea, which extends almost to the borders of the superior surface (*figs.* 11 *and* 13); the trochlea is divided into two prominent ridges by a very deep and rounded median groove; the ridges are slightly oblique to the long axis of the bone, and on the posterior aspect converge slightly superiorly (*fig.* 13); the anterior and posterior extremities of the superior surface are raised into prominences, of which the anterior is much the higher (*fig.* 11); there is a slight depression on the anterior and posterior surfaces at the superior termination of the trochlea. The

lateral surfaces of the bone are nearly flat. Below, the dimensions of the bone are compared with those of the corresponding phalange of the living Indian *Manis* (*Pangolin*) *indica, viz.*:—

	Living.	Fossil.
Length of anterior surface	0·62	1·10
Transverse diameter of dist. extremity	0·30	0·69
Antero-posterior do. do. do.	0·42	0·95
Transverse diameter of superior surface	0·34	0·70
Antero-posterior do. do. do.	0·50	1·05

From the above it will be seen that the fossil bone is very slightly wider in proportion to its length than in the living species: the only other distinction between the two specimens is that in the bone of the living species the depression for muscular attachment above the trochlea on the posterior surface is somewhat larger and deeper than in the fossil specimen. The dimensions of the fossil bone are about double the size of those of the recent bone, and consequently indicate that the fossil animal was about double the size of the living species. The length of the second phalange in the living species is equal to one-seventh of the length of the cranium, and the length of the cranium is about equal to one-tenth of the total length of the body; taking these proportions, the head of the fossil species would be about 7·7 inches in length (that of the recent Indian species being 4·2), and the length of the whole body would be about seventy-seven inches, whereas that of the living Indian species never exceeds forty-three inches, *Manis* (*Pangolin*) *gigantea** of Western Africa attains a length of seventy inches, or rather less than the Siwalik species. The present specimen is distinguished from the corresponding bone of the *Armadillos* and *Orycteropus* by being much shorter in proportion to its length; from that of *Myrmecophaga* by not being enclosed in the terminal claw. It has nearly the same form as that of *Megalonyx*, but is shorter in proportion to its length. With the phalanges of other *Edentata* it has few points in common.

In referring this bone to the genus *Manis*, I assume that the animal to which it belonged must have had the same general organization as the living species; the fossil species was clearly fossorial, and being so, the presumption is that it did not differ far from the living animal, though subsequent discoveries may prove that there were differences in the form of some part of the osteology of the fossil species which will require that it should eventually be placed under a new genus; other remains of this interesting fossil form will, I hope, be subsequently obtained: the locality from which this fossil was obtained has already yielded several little known forms to Mr. Fedden's search, and it is from these Sind and Panjab districts alone that the majority of new Siwalik fossils in the Indian Museum have been obtained.

* The name *Manis gigantea* appears to have been applied to two different animals; it was first applied by Illiger in 1811 to the living African species, and the name is used for this species in Gray's catalogue of the Edentata in the British Museum (1873). Subsequently the same name was applied by Holl in 1830 to Cuvier's *Pangolin gigantesque*, (the latter name dating from 1812); the name therefore belongs to the African species; the fossil species was subsequently named by Lartet *Macrotherium giganteum*. I have not had an opportunity of comparing our specimen with the corresponding bone of the African *M. gigantea*; it is much smaller than that of *Macrotherium*.

Order: CARNIVORA.

Genus Amphicyon, *Lartet.*

Amphicyon palæindicus, *n. sp. Falc. et nobis.* Plate 7, figs. 5, 8, 12.

This genus of extinct *Subursoid mammalia,* distinguished from their living congeners by having been furnished with three instead of two tubercular molars in the upper jaw, has hitherto been definitely known only from the miocene strata of Europe, where four well-marked forms have been determined, *viz., A. major, A. minor, A. dominans,* Meyer, and *A. helveticus,* Pictet, and from the Tertiaries of Nebraska, from which two species, *A. vetus* and *A. gracilis,* have been described by Professor Leidy.

No specimens of the genus were known to Dr. Falconer at the time of publishing the "Fauna Antiqua Sivalensis"; subsequently, however, among a collection of mammalian remains sent to him for determination by Dr. Oldham from tertiary strata at Kúshalghar below Attock, Dr. Falconer (*see* "*Palæontological Memoirs,*" *vol. I, p.* 416) discovered a tubercular upper molar tooth, which he said must have belonged to a carnivorous animal, as large as the *Polar Bear,* and allied to the *Amphicyon.* This tooth was, with the other specimens from the same locality, subsequently returned to the Indian Museum, where it now remains; for the first time I give a figure and description of the specimen (*Pl. IV, fig.* 5). No specific name appears in the account of the specimen in the "Palæontological Memoirs," but in a manuscript of Dr. Falconer's on this specimen given to me by Dr. Oldham, the species is named *A. palæindicus.* It will be observed that in its general form the tooth corresponds with that of the European forms of the genus, but that it presents certain modifications of detail by which it is distinguished: these modifications, however, do not appear to me to justify the placing of the specimen in a separate genus or sub-genus, and I have therefore retained it under *Amphicyon;* it is, however, I think, doubtful from Falconer's remark on the specimen, as being "nearly allied to *Amphicyon,*" whether he himself intended to place it in that genus.

In addition to the above specimen, we have in the Indian Museum another tooth of *Amphicyon* (*Pl.* IV, *figs.* 8, 12): this second specimen is the "carnassial" tooth of the lower jaw—it is of such a size that it seems too large to have been the lower molar of the same species to which the upper molar belonged; to prevent, however, the unnecessary multiplication of species, I have, for the present at all events, referred it to the same species as the former specimen: this tooth was brought by Mr. Medlicott from the Siwalik strata of Nurpúr.

Reverting to the upper molar, we find that the specimen is the second true molar of the right maxilla; it is quite perfect, and belonged to an adolescent animal, as none of the points of the lobes have been touched by wear.

The outline of the crown is nearly in the form of an isosceles triangle, of which the outer border forms the base: the apex of the triangle is rounded off. The

crown-surface is divided into two portions, a blade and tubercular portion, the former occupying the outer side. The blade is divided into two unequal lobes by a transverse valley (by this unequal division of the blade the tooth is distinguished from the first molar, where the two lobes are symmetrical); the two lobes form regular blunted cones, the anterior of which is nearly double the size of the posterior.

The tubercular portion of the crown, which commences at the inner base of these lobes, has an approximately flat general surface; the inner border of this surface is surrounded by a flattened semi-circular rim about a quarter-of-an-inch in width at its broadest part; within the concavity of this rim, and separated from it by a portion of the general flat surface of the crown, there is placed a very low and blunt cone, slightly elongated antero-posteriorly.

A narrow cingulum embraces the outer borders of the blade. In the following table the dimensions of this specimen in inches and tenths (in the first column) are compared with those of the corresponding tooth of the European *Amphicyon major* (in the second column) :—

Length of blade	0·76	0·87
Length at centre of tubercular portion	0·55	0·75
Greatest width	1·12	1·3
Height of anterior lobe of blade	0·4	0·52

From this it will be seen that the present specimen in all its dimensions is of rather smaller size than the corresponding molar of *Amphicyon major;* taking the latter species as a typical form of the genus, we may compare the teeth of the two species. (*A figure of the upper molars of A. major is given in De Blainville's "Osteographie" Atlas, vol. II, Sibursi, pl.* XIV.) The general form of the blade is very similar in the two specimens; the anterior cone, however, is rather larger in proportion to the posterior in the Indian than in the European form, and in the latter the two cones are divided by a deeper channel on the outer side. The greatest difference in form occurs in the tubercular portions of the two teeth; in place of the simple cone situated within the raised rim of the innermost border of the crown of *A. palæindicus*, we find in *A. major* a second semi-circular elevation placed within the first; this central semi-circle runs up to join the angles of the lobes of the blade; at the base of the hindermost of these lobes, the central semi-circle is raised into another smaller cone; finally the semi-circular rim on the internal border of the crown is crenulated in the European form, while it is quite simple in the Indian.

These differences give a very marked variety in the contour of the two teeth; if, however, we examine the corresponding tooth of another and smaller European species—*A. dominans of Meyer*—we find that the central semi-circular rim only exists on the anterior half of the crown, the posterior half of which is quite level; this anterior ridge terminates in a small blunted cone, occupying the same relative position on the crown as does the isolated cone on the crown of the Indian specimen.

It will, therefore, be seen that there is a transition from the complete semicircular ridge, which occupies the centre of the crown of the tooth of *A. major*, to the single cone occupying the place of the middle of this arc in the tooth of *A. palæendicus.*

The present specimen, besides other characters, is at once distinguished from the other three European and the American species by its much larger size, from *A. helveticas* (*see* Pictet *"Paléontologie Suisse," vol. V, p.* 135) it is further distinguished by the small size of the cingulum surrounding the blade.

The lower molar belonged to a somewhat larger animal than the upper molar. The specimen comprises a portion of the right ramus of the mandible containing two teeth; the first of these is the last of the milk-molar series; the summit of the second lobe of the blade has been broken away; the crown is considerably worn. The second and much larger tooth is the first of the permanent molar series,—the "carnassial"; it is quite perfect; none of the casps have been touched by wear, and the jaw has been partly chisselled away to expose the base of the crown.

Viewing the carnassial from the outer side (*Pl.* 7, *fig.* 8) we may call the whole of the outer surface the blade of the tooth; this blade is separated into three portions, of which the middle one is the highest; the anterior and posterior lobes are nearly of the same height, by which character the carnassial of *Amphicyon* is distinguished from that of *Canis,* in which the third lobe of the blade is very low, and almost forms a part of the tubercular portion of the crown. A narrow vertical groove runs down the postero-external angle of the median lobe. The anterior and median lobes are separated only by a slight notch on their upper border; a deep valley, extending down nearly to the base of the crown, separates the median from the third lobe. The anterior lobe presents a simple trenchant edge; the median lobe is placed somewhat obliquely to the long axis of the crown, and has a narrow trihedral accessory-column at its postero-internal angle.

The third lobe is a laterally-flattened cone, with a fore-and-aft cutting edge; at the base of its internal surface there is a narrow flat ledge which forms the only truly tubercular portion of the crown. The third lobe, the accessory-column of the median lobe, and the tubercle, enclose a hollow triangular space between their respective bases.

The last molar of the deciduous series presents in miniature the form of the larger tooth; it agrees precisely both in shape and size with the permanent carnassial of the European *A. dominans.*

The dimensions of the larger tooth of the Indian species (in the first column) are compared with those of the lower carnassial of the European *A. major* (in the second column)—

	In.	In.
Length of tooth	1·32	1·2
Width at hinder extremity	0·6	0·5
Height of central lobe	0·9	0·7

The lower molar of the Indian form is, therefore, as much larger than the corresponding tooth of *A. major*, as the upper is smaller; assuming that the proportion between the lower and upper teeth is the same in the Indian form as in the European, the width of the upper molar corresponding to this specimen should be 1·4 inches, whereas the width of the Attock specimen is only 1·12 inches; from this I think it quite probable that there may be two Indian species of the genus.

The present specimen is chiefly distinguished (in addition to its greater absolute size) from the carnassial of *A. major* by the greater proportionate size and thickness of the third lobe, and by the presence of the groove on the outer side of the middle lobe. The depth of the jaw in this specimen is nearly the same as in *A. major*. From all the other small European and American species, the large size of the present specimen is a sufficient distinction.

CRANIA OF RUMINANTS FROM THE INDIAN TERTIARIES.

By R. LYDEKKER, B.A.

GEOLOGICAL SURVEY OF INDIA.

[WITH PLATES XI—XXVIII.]

Among a series of (chiefly) unpublished notes and plates,[1] intended for the completion of the "Fauna Antiqua Sivalensis," the late Dr. Falconer has indicated the existence of a large and varied Ruminant Fauna which inhabited India in tertiary times; this fauna must have been at least equal in extent in the number of peculiar forms to the well-known Proboscidian Fauna of the same epoch. More or less complete remains of certain of these Ruminants, such as *Sivatherium, Bramatherium, Camelus, Camelopardalis,* and the *Bovina* of the Nerbudda valley, have already been figured and partly described in the "Palæontological Memoirs" and in the publications of the Asiatic Society of Bengal. Figures of the crania of several species of *Bovina* have been drawn or engraved among the unpublished plates of the "Fauna Antiqua Sivalensis." A notice of all the species of Indian Fossil Ruminants known to Falconer will be found in the first volume of the "Palæontological Memoirs."

In the present memoir I have given figures and descriptions of all the Bovoid Ruminants at present contained in the collection of the Indian Museum, identifying as many of them as agree with such of Falconer's species of which there is any figure or description extant: many, however, of Falconer's species exist only on the authority of manuscript names without figures or descriptions: these species I have, of course, been obliged to completely reject. The total number of species of Bovoid Ruminants named by Dr. Falconer from the Siwaliks was six, *viz.*, *Bison sivalensis, Bos occipitalis, Hemibos triquetriceros, Amphibos acuticornis, Amphibos elatus,* and *Amphibos antilopinus:* figures of the crania of the third and fourth of these species are given in the unpublished plates of the "Fauna Antiqua Sivalensis" (*Plates G. and H.*), while measurements of the crania are also given in the accompanying descriptions of the plates: of *Hemibos triquetriceros* we have several crania in the Indian Museum; and several also of *Amphibos acuticornis.* Of the cranium of *Bison sivalensis* there is an outline figure in the drawings intended for the completion of

[1] Of these plates, the Indian Museum has recently acquired photographic copies, which have been executed under the superintendence of the British Museum Authorities.

the "Fauna Antiqua Sivalensis" (*Plate A, sheet 10*); of this figure I have obtained a copy by the courtesy of the British Museum authorities, and find that it corresponds in character with a cranium of *Bison* in the Indian Museum collected by Mr. Theobald, and which I have accordingly referred to this species. Of *Amphibos elatus* and *Amphibos antilopinus* I cannot find any descriptions or figures, and the names must therefore be abandoned. Of *Bos occipitalis* we have likewise no certain means of identification; Dr. Murchison, the editor of the "Palæontological Memoirs," has, however, suggested in a marginal note (*Vol. 1, p. 281*) that this name may refer to a cranium of a Bovine Ruminant contained in the Siwalik collection of the Asiatic Society of Bengal, which was shortly described by Falconer in the Catalogue of the Collection, but to which, he, at that time at least, applied no specific name. Whether this name could have been applied to the specimen in question depends in a great measure on the respective dates of the manuscript note in which the name occurs and of the Museum Catalogue: the date of the latter is 1859; if the note were written previously to that date, it is quite clear that the name did not apply to the specimen, or it would have appeared in the Catalogue. As I have no means of judging on this question, I have thought it would prevent confusion to follow Dr. Murchison and to continue to apply the specific name to the cranium in question; the generic name I have, however, changed to *Peribos*, as the species cannot be referred to the restricted genus *Bos*.

Besides the *Bovidæ*, Falconer indicated the existence of three species of Siwalik Antelopes; two of these species, *viz.*, *Antilope gyricornis* and *Antilope picta*, are known only by manuscript names and must consequently be abandoned; the cranium of the third species, *Antilope palæindica*, is, however, figured in the "Palæontological Memoirs" (*Vol. 1, pl. 23*), and the species may consequently stand.

The peculiar form, *Hemibos triquetriceros*, seems to have been a small Bovoid animal, forming a connecting link between the Oxen and the Goats. *Amphibos acuticornis*, on the other hand, in the form of its horn-cores, connected the Oxen and the Antelopes; it was perhaps allied to the Bovoid *Anoa depressicornis* of the Island of Celebes.

Of the true *Bovidæ* there are at the present day seven well-marked species inhabiting South-eastern Asia; these are, *Bubalus arni* inhabiting the Sâl forests of Assam, the Nepal Terai, parts of upper Bengal, the Sunderbans, and the highlands of Central India; *Bibos gaurus* inhabiting the eastern Sub-Himalayas, the Nerbudda valley and adjoining hills, and parts of Burma; *Bibos frontalis* inhabiting the hilly districts to the eastward of the Brahmaputra; *Bibos banting* inhabiting Burma and Pegú; the domesticated *Bos indicus* of the plains; *Bos chinensis*, partly domesticated over a great part of China; and lastly, *Bison (Poephagus) grunniens* of Tibet.

There is no true taurine ox at the present time living anywhere in Asia, the aberrant *Bos indicus* being the only representative in India of the genus *Bos* as

restricted by Hodgson and Gray. With the exception of the Buffalo all the wild cattle of India proper belong to the genus *Bibos:* I have not, however, in the Indian Tertiaries found the remains of any fossil species which belongs to this characteristic Indian group, though several of the fossil oxen approach this group in many points of structure of the cranium.

Of the restricted genus *Bos,* I have described the crania of four fossil species, one of which is from the valley of the Nerbudda, and the other three are from the Sub-Himalayan Siwaliks; two species from the latter area, *viz.*, *Bos acutifrons* and *Bos planifrons,* will be found to differ to a certain extent in the form of the occipital surface from the crania of any living species of oxen; this divergence from the type form will be found carried to a still greater extent in the occiput of *Bos namadicus* from the Nerbudda valley; and the divergence is greatest of all in the living Indian wild cattle composing the genus *Bibos.* It is an interesting fact to note that the peculiarly formed occipital region of the living genus *Bibos,* at present exclusively confined to the oriental region, is found foreshadowed among the Indian fossil species alone of the many forms of the genus *Bos;* in one species at least (*B. namadicus*) this abnormal form of the occiput is correlated with small premaxillæ like those of *Bibos,* which are never found in any European ox.

It may therefore not be improbable that *Bos namadicus* may have been one of the progenitors of the living wild Indian cattle.

Bos planifrons, a new species from the Siwaliks, presents some points of resemblance to the Nerbudda species, but does not come very close to any living species. The long-horned *Bos acutifrons* is widely different from all other recent and fossil species, and presents certain affinities to *Bubalus*—the same remark will apply to the third Siwalik species, *Bos platyrhinus.*

Bison sivalensis may probably be considered as the direct ancestor of the living Himalayan *Bison* (*Poephagus*) *grunniens.*

The living *Bubalus arni* of India is without doubt the direct lineal descendant of the gigantic *Bubalus palæindicus* of the gravels of the Nerbudda, and of the topmost beds of the Siwaliks. With regard to the propriety of making distinct species out of these two closely allied forms, we may note that the living wild cattle of the English parks and the aurochs of Lithuania are generally regarded as the direct and but little altered descendants of the fossil *Bos primigenius* and *Bison priscus,* and yet are frequently considered as distinct species in the modern modified acceptation of the term. It appears to me to be the best course to give a distinct specific name to every distinguishable form; since it is only by describing the small varieties which exist between allied forms of the same type of animals that we are enabled to obtain evidence of the descent of one so-called species from another. It may hereafter be advisable to invent a title which shall comprehend in one group all those so-called species which can be proved to be the lineal descendants of one original form; the term species may either be taken in this larger sense or as the name of distinguishable forms of one period only.

The second fossil Indian species of the genus, *Bubalus platyceros*, is from the Siwaliks, and differs in the form of its cranium from that of any living species of the genus; this difference mainly consists in the long upward prolongation of the frontals between the bases of the horn-cores and in the want of the high and vertical occiput; by these peculiarities it shows an affinity to the Antelopes which Professor Rutimeyer regards as the progenitors of the true Oxen.

Among the fossils from the mammaliferous beds of the Irawadí River now contained in the Collection of the Indian Museum, there are several fragments of cylindrical horn-cores of small size, together with a single upper molar tooth; these specimens evidently belonged to a species of Bovoid Ruminant; but they are of course too fragmentary, even for generic distinction; it will be interesting if more complete remains should hereafter be discovered to determine whether or no the fossil ox of the Irawadí beds was at all related to *Bibos banting* now inhabiting the same regions.

The crania of nearly all the species of fossil Indian cattle show certain modifications of form which render them more or less aberrant from the living types of their respective genera, making it a matter of considerable doubt in some cases whether to refer them to the existing genera or to make new genera or sub-genera for their reception. When possible, I have generally placed the fossil species under the recent genus, if there were several important characters common to the living and fossil types; not unfrequently, however, the fossil species will not bear a rigid interpretation of all the characters of the genus under which it has been placed; this will be found to be the case with *Bos namadicus*, *Bos acutifrons*, and *Bubalus platyceros*. A difficulty of this kind must always be expected to arise when we have to deal with a large series of recent and fossil forms, and is one which tends to do away with some of the sub-genera of modern Zoologists which are only founded on minute and unimportant points of detail.

The Siwalik being one of the largest fossil Bovine fauna hitherto described, it would not be unreasonable to suppose that it would be also the most rich in the number of genera; this we find in fact to be the case; the three chief groups of living oxen, *viz.*, *Bos*, *Bison*, and *Bubalus*, being each represented by one or more species, and there are, besides, several extinct genera or sub-genera unknown in other deposits. In no region of the world at the present time are the three above-mentioned genera found living together, though there is the nearest approach to it in modern India, where *Bibos* (representing *Bos*) and *Bubalus* are found in the plains, and *Bison* represented by *Poephagus* in the Himalayas, the latter separated, however, completely from the genera of the plains.

The crania of the fossil Indian oxen tend to do away with the distinctions which separate the genus *Bibos* from *Bos;* the three genera, *Bos*, *Bison*, and *Bubalus*, are found to have possessed their most important craniological distinctions in Siwalik times, and to have preserved them with some slight modifications up to the present day. This is quite in accordance with the discoveries of Palæontologists

in other countries. Professor Rutimeyer, in his "Ancient Ruminant Fauna of Switzerland," considers the derivation of the three genera to have taken place in the following order, commencing from the oldest, *viz.*, *Bubalus*, *Bison*, and *Bos;* the high frontal ridge of the latter genus the Professor considers as a highly specialised character, which did not make its appearance in Europe till the post-Pliocene period; in India this character must have been differentiated at an earlier period, as the remains of *Bos* are found throughout the Siwalik, which we cannot regard as being newer than older Pliocene.

The remains of Sheep have hitherto been met with very rarely in the Indian Tertiaries; we have no remains of this group in the Indian Museum. Goats are also rare, but I have distinguished three species, one of which was probably the ancestor of the living Markhoor, while another seems more closely allied to the Nilghiri *Hemitragus hylocrinus;* the third species does not show affinity to any living Indian form.

Including the new species described in the present Memoir the list of Indian Tertiary Ruminants will be as follows:—

	PECORA.	
BOVIDÆ ...	*Bos namadicus*—Nerbudda. *Bos planifrons*—Siwalik. *Bos acutifrons*—Siwalik. *Bos platyrhinus*—Siwalik. *Bubalus platyceros*—Siwalik.	*Bubalus palæindicus*—Nerbudda and Up. Siwalik. *Bison sivalensis*—Siwalik. *Peribos occipitalis*—Siwalik. *Hemibos triquetriceros*—Siwalik. *Amphibos acuticornis*—Siwalik.
ANTILOPIDÆ ...	*Antilope palæindica*—Siwalik. *Antilope patulicornis*—Siwalik.	*Antilope sivalensis*—Siwalik. *Antilope porrecticornis*—Siwalik.
SIVATHERIDÆ ...	*Sivatherium giganteum*—Siwalik. *Vishnutherium iravadicum*—Burma.	*Bramatherium perimense*—Perim Island. *Hydaspitherium megacephalum*—Siwalik.
CAMELOPARDALIDÆ.	*Camelopardalis sivalensis*—Siwalik,	
CAPRIDÆ ...	*Capra sivalensis*—Siwalik. *Capra perimensis*—Perim Island.	*Capra sp.*—Siwalik.
OVIDÆ ...	*Ovis sp.*—Siwalik (Blyth).	
CERVIDÆ ...	*Cervus latidens*—Siwalik. *Cervus triplidens*[1]—Siwalik. *Cervus simplicidens*—Siwalik. *Cervus sp.*—Burma.	*Cervus sp.*—Nerbudda. *Dorcatherium minus*—Siwalik and Manchhars. *Dorcatherium majus*—Siwalik, and Sind and Attock Beds.
	TYLOPODA.	
CAMELIDÆ. ...	*Camelus sivalensis*—Siwalik.	

The three species of oxen, *Bos acutifrons*, *Bos planifrons*, and *Bubalus platyceros*, and also the peculiar genus *Hydaspidotherium* or *Hydaspitherium*, have been already named and noticed by me in the Records of the Geological Survey of India.[2]

In regard to the distribution in time of the fossil Indian genera of Ruminants, we find that in Europe the remains of the restricted genus *Bos* are only found in Pleistocene and recent strata: in Nicholson's Palæontology (p. 439) it is stated that

[1] The teeth of this species are so like those of *Bos* that it may be well to mention that they have been found attached to a part of an undoubted cervine skull.

[2] Vol. IX, p. 154, and X, p. 30.

"a few remains of *Bovidæ* have been found in deposits of Pliocene age, but the oxen are essentially *post-Pliocene* and *Recent;*" the same remarks apply to the genera *Bubalus* and *Bison.* Professor Dana,[1] in noticing the Mammalia of the Siwaliks, considers these deposits to be of upper Miocene age, but adds the significant remark: "*Bos* and the related genera probably occur nowhere earlier than the Pliocene," apparently not being aware that the remains of these genera are found in the same deposits as those of *Sivatherium* and *Acerotherium;* the whole series will consequently be of Pliocene age. As I have already stated elsewhere,[2] the presence of a large assemblage of bovoid genera in the Siwaliks is a most important argument for the Pliocene age of that formation; they occur in the same beds with *Chalicotherium* and other Miocene forms, which latter must have lived down to a later period in India than in Europe. This probable survival of *Chalicotherium* (and what applies to one genus applies to another) in Asia down to times later than the Miocene has been already noticed by Professor Owen[3] in his description of certain Fossil Chinese Mammalia. That author, who followed Dr. Falconer in considering the Siwaliks as of exclusively Miocene age, remarks: "If the Anoplotherioid molar had not been in the series, such series would have been referred, without hesitation, to a geological period not older than the upper Pliocene, and with a possibility of post-Pliocene age.

"I accept the evidence of the majority of the fossils, with the older alternative, and conclude that this particular Anoplotherioid Artiodactyle, which has departed from the generalised character of the type-genus by the suppression of a premolar on each side of both jaws, and the commencement of a diastema or break in the dental series, continued to exist in China, until the Pliocene division of tertiary time, perhaps to a late period of that division."

The above view quite concurs with my interpretation of the value of the different genera in determining the age of the Indian upper tertiaries; at the same time it seems not improbable that some Siwalik fossils, such as those of Sind and Kúshalgar, do really belong to the upper Miocene period, there being no lithological break in the latter area between the Nummulitics and the Siwaliks.

The genera, or sub-genera, *Hemibos, Amphibos,* and *Peribos,* are exclusively confined to the Siwaliks; they belong to more generalised types than the true oxen, and therefore claim affinities with older forms. The genus Antilope or an allied sub-genus just occurs in the Miocene strata of Attica and Montpelier, and has lived down to the present time. The four allied genera composing the peculiar family of the *Sivatheridæ* are confined to the Indian tertiaries. The genus *Camelopardalis* is first known from the Miocene of Attica, and now exists in Africa only. The genera *Capra* and *Ovis* have in Europe been discovered in post-tertiary formations only, and therefore, like the *Bovidæ,* give an exceedingly modern facies to the fauna in

[1] Manual of Geology, p. 520.
[2] Records of the Geological Survey of India, Vol. IX, p. 98.
[3] Quar. Journ. Geol. Soc., Vol. XXVI, p. 432.

which they occur: the presence of these fossils in the Siwaliks in company with *Chalicotherium* and *Dorcatherium* must induce us to believe that these genera originated in India in some part of the Pliocene period, and did not reach Europe until the post-tertiary period. The genus *Cervus* seems to have been represented in the upper Miocene of Europe, but did not attain to importance until the Pleistocene period; it belongs to an essentially modern group; the allied genus *Dorcatherium* in Europe is confined to the Miocene period, but lived in the Siwalik period of India. The genus *Camelus* is unknown in a fossil strata except in India, though allied forms like *Procamelus* occur in the upper tertiaries of America; the genus is probably an essentially modern one.

The fossil Ruminants of the Indian tertiaries therefore all point very strongly to the modern age of the deposits, there being only one exclusively Miocene genus among them. Were we to study the Indian tertiaries from this group alone, we should be compelled to place the Siwaliks in the upper Pliocene period at the earliest; but this view must be modified by the greater number of Miocene forms which we find in other groups of the Mammalia.

In a former paper on the Fossil Mammalia of India and Burma,[1] I stated that the "number of extinct genera of Mammalia in these beds (Siwaliks) is so large" that on these grounds we might consider them to be of Miocene age: this statement was made from the comparison of the Mammalia fauna of the Indian and European later tertiaries, and is true if we confine ourselves to those regions; if, however, we extend our comparisons to the later tertiaries and post-tertiaries of America and Australia, we shall find that in the latter countries a vast number of extinct mammalian genera are found in strata of Pleistocene age, while in Europe all the genera except *Megaceros* from the Pleistocene, and most of those from the Pliocene, are still existing on the globe. Thus, in the Pleistocene of America we have among others the extinct genera *Megatherium*, *Mylodon*, *Megalonyx*, *Scelidotherium*, *Glyptodon*, and *Mastodon*; while in the corresponding strata of Australia we have *Diprotodon*, *Nototherium*, and *Thylacoleo*; again, to take an instance from the class of birds, we have in very modern strata in New Zealand, *Dinornis*, *Palapteryx*, and several others. The proportionate number of extinct genera in the Siwaliks cannot therefore be considered as being of any great value in determining their age; the only evidence which tends to place these deposits in the Miocene period is the presence of genera characteristic of this period in Europe; their occurrence, however, as I have before said, is to be explained by their later survival in India, and its value as evidence is over-balanced by the large percentage of strictly modern genera in the Siwaliks.

The plates in this part all bear the name of the native artist who has executed the outlines and a considerable part of the shading; in many instances, however, the finishing touches have been given by Mr. Schaumburg, the Artist to the Geological Survey of India.

[1] Rec. Geol. Surv. India, Vol. IX, p. 97.

Before proceeding to specific descriptions, it may be well to state that in the present work I have used generic terms in contradistinction to sub-generic terms, in all cases; one reason for this is, that the crania of the different forms of extinct oxen generally differ from one another, more than do the crania of *Bos* and *Bubalus*, which latter are frequently considered as generic, and not as sub-generic divisions. If sub-generic terms were to be used in any case among the oxen, it appears to me that they should be used in all cases, and that consequently all the forms of oxen[1] described in the present Memoir should then be considered as belonging to different sub-genera of one large genus *Bos*. I, however, prefer to use the term *Bovidæ*, somewhat in the latter sense, and to place the distinct types, as I have done below, in distinct genera. The reader can, if he prefers, of course consider the generic terms of the *Bovidæ* employed here as being merely of sub-generic value, without interfering with the general scheme of the classification employed.

ORDER UNGULATA: SECTION SELENODONTA: DIVISION ARTIODACTYLA.

Family: BOVIDÆ.

GENUS: BOS.

The genus *Bos* may be defined from the characters of the cranium as follows:—

Horn-cores placed immediately over the plane of the occiput; occipital crest extending high up between the bases of the horn-cores, and the occiput generally squared, and with very slight lateral indentations of the temporal fossæ: forehead flat or mesially ridged, longer than broad, and frontal longer than facial portion of cranium; superior border of horn-cores at first convex; in typical species the intercornual space is straight and the horn-cores are cylindrical; in some aberrant varieties the horn-cores are compressed, and the intercornual space is somewhat arcuated.

It will be observed that the above definition differs in several points from those given by Hodgson[2] and Gray[3]; these alterations have been rendered necessary by the new species now introduced into the genus.

BOS NAMADICUS, *Falconer*. Pls. 11 and 16, f. 1 & 3.

Of the cranium of this, one of the best known species of the fossil Indian oxen, figures and an imperfect description have already appeared in the Journal of the Asiatic Society of Bengal (*Vol. X, Pl. F, figs. a, b*), and figures have also been given in the unpublished plates of the "Fauna Antiqua Sivalensis" (*Pl. G, figs. 1 a, b, c, 2*

[1] With the exception, perhaps, of *Amphibos*.
[2] Asiatic Society of Bengal, Vol. X, p. 452.
[3] Catalogue of *Ungulata* in the British Museum.

a, b, c); copies of two of these figures have been reproduced in the "Palæontological Memoirs" of Dr. Falconer (*Vol. I, Pl. XXII*); short descriptions of other crania of this species are also given by Dr. Falconer in the Catalogue of the Mammalian fossils in the Collection of the Asiatic Society of Bengal; these descriptions have been likewise copied in the "Palæontological Memoirs" (*Vol. I, p. 286*).

In the accompanying plates I have given a figure of a very perfect cranium (*Pl. XI*) of this species obtained from the Nerbudda valley, and now in the Indian Museum; this specimen, though far more perfect, agrees exactly in all its characters with the specimen of the cranium figured in Plate G, fig. 2 *a, b, c*, of the unpublished plates of the "Fauna Antiqua Sivalensis," and which I take as the type of the species; an occipital view of the same specimen is given in Plate XVI, fig. 1. The specimen of the frontlet and horn-cores of another species of ox of which a front view is given in Plate XII, fig. 2, and an occipital view in Plate XVI, fig. 4, was obtained by Mr. Theobald from the Siwaliks; this specimen, especially in the form of its occipital region, seems at first sight to differ very widely from the Nerbudda species; if, however, we refer to the second specimen figured in the "Fauna Antiqua Sivalensis" (*Pl. G, fig. 1 a, b, c*), and of which the front view is given in the Palæontological Memoirs" (*Vol. I, Pl. XXII, fig. 4*), while the occipital view is copied in the present Memoir (*Pl. XVI, fig. 3*), we shall find that that specimen exhibits characters intermediate between the Siwalik and the type Nerbudda species, and forms, therefore, a connecting link between the two, though the form of the horn-cores in the two is a sufficient specific distinction.

I will first of all shortly describe the figured Nerbudda cranium, and then point out in what respects it differs from those of other species of oxen. The forehead is long and narrow, and equal in length to the face; between the horn-cores it is almost flat, while at the level of the orbits it is slightly concave in the middle line; the orbits are relatively of large size, their anterior borders are placed very slightly behind the plane of the frontals, and are approximately parallel to the long axis of the cranium, the axis of the orbit consequently looking almost directly outwards. The supra-orbital foramina pierce the frontals at right angles, inferiorly they are continued into long and deep sulci, which run nearly parallel to each other, and extend downwards as far as the inferior border of the orbit; the surface of the frontals is somewhat more elevated on the inner than on the outer side of these sulci, which are upwards of six inches in length.

The maxillæ run nearly parallel to each other for a length of about five inches and then contract somewhat suddenly in width, a well-marked tuberosity being placed at the point of contraction. The nasals are long and somewhat arched from side to side; between these bones and the maxilla there occurs a long triangular vacant space; the apex of the nasals extends upwards only as far as the lower border of the orbit; a long interval separates the latter from the base of the horn-core.

The ridge between the horn-cores has a large ovate tuberosity occupying its middle third; in some specimens this tuberosity is less marked than in the figured

cranium, and the intercornual ridge consequently then forms an almost unbroken arch. At the upper part of the forehead, the frontals slope slightly backwards to join the intercornual ridge, which is placed rather behind the plane of the face; this ridge is produced upwards and backwards so as to overarch to a considerable extent that part of the occipital surface intended for the attachment of the vertebro-cranial muscles; from its highest point the intercornual ridge slopes gradually downwards and backwards to join the occipital crest; the surface of that part of the occiput which is above the crest being in consequence placed posteriorly to that part which is below the crest. The occipital crest itself forms a continuous and unbroken arch, which is separated by a considerable interval from the intercornual ridge. The paroccipital process of either side is separated by a deep groove from the occipital condyle. The bases of the horn-cores do not extend more than one-and-a-half inches below the highest point of the occipital crest or curved line; and there is a wide interval between the former and the lateral borders of the crest. The temporal fossæ form small triangular notches immediately below the bases of the horn-cores on the occipital surface; the plane of the latter forms an acute angle with the plane of the frontals. The palate is in too imperfect a condition for accurate description; it is, however, but slightly produced backwards behind the molar series, and the line of the latter is very concave internally; the basioccipital is triangular in form as in the typical oxen, and carries four tubercles for muscular attachment, of which the posterior pair are the larger and are separated by a wider interval than are the anterior pair.

The horn-cores are placed on the highest ridge of the skull, immediately above the plane of the occiput; in cross section (*Pl. XI, figs. 3 & 4*) they are nearly circular in the middle, but have a slight ridge along their superior border; at their base they are somewhat slightly compressed from side to side, the cross section being pear-shaped at this point; they diminish in width very gradually; their direction is at first upwards, outwards, and slightly forwards, then nearly directly forwards, and finally inwards and slightly upwards; at their extremities they are placed at a distance of nearly two feet in advance of the plane of the frontals. The measurements of the cranium are as follows :—

Length from foramen magnum to diastema	12·5
„ „ intercornual ridge to apex of nasals	13·0
Height from lower border of foramen magnum to occipital crest	5·8
Interval between occipital crest and intercornual ridge	2·5
Width at inferior border of orbits	8·6
„ at superior border of orbits	10·0
„ below orbits	7·4
„ above „	8·1
„ of occiput through petrosals	10·3
Height from surface of palate to frontals	6·6
Interval between outer angles of condyles	5·2
Length of temporal fossa	6·5
„ of intercornual ridge	9·0

Height from palate to tip of nasals	3·2
Interval between orbit and base of horn-core	5·3
Transverse diameter of left orbit	2·7
Antero-posterior diameter of left orbit	3·1
Length of line of five molars	5·9
Greatest width of palate	3·8
Interval between outer surfaces of second molars	5·8
Length of left horn-core, upper surface	39·0
„ „ „ lower „	32·0
Antero-posterior diameter of base of left horn-core	3·8
Circumference of ditto	12·5
Transverse diameter of ditto	3·4
Interval between tips of horn-cores	36·0
„ „ supra-orbital foramina	5·7
Width of nasals at widest part	2·7

I will now notice another frontlet of the same species in the Indian Museum, collected by Mr. Hacket in the Nerbudda valley; it belonged to a rather larger animal than the preceding specimen. The general form of the frontals of the two specimens is similar, the horn-cores, however, of Mr. Hacket's specimen, instead of a nearly circular, present an elliptical cross section, while, continuous with the intercornual ridge, a well-marked ridge runs along the upper border of the horn-core; the form of the horn-core of this specimen indeed approaches very closely to that of the male *Bibos gaurus*. The horn-cores are more massive and taper less rapidly than in the preceding specimen, while the ridge between the base of the horn-cores is quite straight, and without any median prominence; the dimensions of the specimen are as follows:—

Length from intercornual ridge to apex of nasals	13·0
Interval between superior curved line of occiput and intercornual ridge	3·5
Width at superior border of orbits	10·4
„ at constriction above ditto	8·5
Length of intercornual ridge	9·0
Interval between orbit and base of horn-core	5·5
„ „ supra-orbital foramina	5·6
Antero-posterior diameter of base of horn-cores	5·2
Transverse ditto ditto	4·1
Circumference of ditto	16·0

Two other specimens of the frontlet of the Nerbudda ox, in the Collection of the Indian Museum, have horn-cores of which the cross seetion is intermediate in form between those of the horn-cores of the two last specimens. The following measurements show the difference in the form of the horn-cores of four individuals of this species; the specimen in the first line is Mr. Hacket's above-mentioned specimen, those in the two middle lines are the two frontlets here referred to, while that in the last line is the cranium figured in Plate XI; the measurements are taken at the base of the horn-cores:—

	Ant.-post. diam.	Tran. diam.	Diff.	Girth.
Flat-horned variety	5·2	4·1	1·1	16
Intermediate ditto	5·1	4·2	0·9	15
2nd ditto ditto	4·7	3·8	0·9	13·5
Round-horned ditto	3·8	3·4	0·4	12·5

In the Catalogue of the Fossil vertebrate of the Asiatic Society of Bengal,[1] Dr. Falconer has noticed several fragments of crania and horn-cores which belong to this species; it seemed, however, that at that time he was somewhat doubtful of the distinctness of the present species, since he in some cases refers to the remains simply as belonging to a species of *Bos* and at others as belonging to *Bos namadicus.* Owing to this uncertainty of nomenclature, it appears that Mr. Theobald[2] was led into error in founding the so-called new species, *Bos falconerianus;* he appears to have thought that in the description of the horn-core marked 30 in the Catalogue and there called simply *Bos,* Dr. Falconer had intended to argue for the specific distinctness of that horn-core from both *Bubalus palæindicus* and *Bos namadicus;* whereas in reality Dr. Falconer was only arguing for the distinctness of the specimen from *Bubalus palæindicus* and the two living species of *Bibos.* A more careful perusal of the Catalogue would have shown such to have been the view of the author, because the next specimen in the Catalogue (No. 31) is named *Bos namadicus,* and Dr. Falconer in noticing it says that "it presents the same characters as No. 30," clearly showing that he considered the two identical; again, in the description of No. 33 (*infra*) Dr. Falconer refers to No. 30 as having belonged to a male of *Bos namadicus.* An examination of the two specimens of horn-cores, 30 and 31, shows that they are quite similar in form, and that they also agree with the horn-cores of the specimen of *Bos namadicus* figured in Plate XI of this memoir. *Bos falconerianus* must therefore be considered as *Bos namadicus* only. As the specimens of horn-cores of this species in the Asiatic Society's Collection are of larger size than any of those here described, I will here quote Dr. Falconer's notes on them as given in the Catalogue. Speaking of the above-mentioned specimen of a horn-core (No. 30), Dr. Falconer uses the following words: "*Bos*—Enormous horn-core of bovine ruminant, encrusted with matrix, much curved in the outline, and nearly circular in section. Girth five inches above base, 1 foot 7 inches; length along convex curve 3 feet 8 inches; diameter where tip is broken off, 3 inches. It is much more circular than that of the Gour or Gayal, in which respect it differs still more than the *Bos* (*Bubalus*) *palæindicus,* and it would appear to indicate a distinct fossil species now extinct." This specimen is the largest horn-core of *Bos namadicus* that I have seen; it agrees with that of our figured specimen in belonging to the round-horned variety. The next specimen in the Catalogue (No. 31) is entered by Dr. Falconer as belonging to *Bos namadicus,* and is referred to in the following words: "Fragment of horn-core, left side, detached, presenting the same characters as No. 30,—namely, with curved outline and nearly circular in section; it is less covered with matrix, and at the upper and convex edge shows a ridge similar to (the horn-core of) *Bos* (*Poephagus*) *grunniens,*

[1] "Catalogue of the Fossil Remains of Vertebrata from the Sewalik Hills," etc., in the Museum of the Asiatic Society of Bengal, Calcutta, 1859.

[2] Mem. Geol. Surv. Ind., Vol. II, p. 293.

which it resembles also in circular section. Length 11 inches; girth near base 14¾ inches; at small end of specimen 13 inches."

A portion of a cranium of *Bos namadicus* (No. 33) from near Jhansí Ghât on the Nerbudda is described by Dr. Falconer in the following words: "Mutilated cranium, presenting the occipital and sphenoidal region nearly entire, left occipital condyle and right mastoid (process) complete; occipital and frontal surfaces perfect from superior margin of foramen magnum to the commencement of the nasals; cores of both horns broken off, on the left side within the base of the pedicle of the core, and on the right side the fracture includes the base of the core, the margin of the frontal and orbit, all of which are removed. A portion of the upper border of left orbit remaining. The frontal plane longitudinally is slightly convex with a shallow concavity upwards between the commencement of the horn-cores. The vertex projects posteriorly to a great extent so as to over-arch the plane of the occipital condyles 2¾ inches. Occipital region concave from above downwards; in these two respects differing very notably from the skulls of the Gour and Gayal. Judging from the section of the core on the left side, it was more or less cylindrical in form, in this respect also differing from those two species.

"Length of specimen from vertex to broken margin in front 13 inches; height from posterior edge of body of sphenoid to vertex about 8½ inches; width of skull at base of occiput 9½ inches; height of occipital surface from inferior margin of foramen magnum to posterior border of vertex 7¼ inches; long diameter of occipital condyle 2¾ inches; short ditto 1·6 inch; width of frontal at constriction behind orbits 8¼ inches.

"Dr. Spilsbury says that this cranium and the specimen No. 31 were found in the same place; they were marked Nos. 1 and 2. In conjunction with the *huge horn-core No. 30,* they would appear to afford conclusive evidence of a fossil species of *Bos* from the Nerbudda distinct both from *Bos* (*Bubalus*) *palæindicus* and the Gour and Gayal, or any other described existing form. From the complete synostosis of the two frontals, it is inferred that the animal was an aged adult, and the smaller size of the horn as compared with specimen No. 30 would seem to indicate that it was a female."

We will now compare the specimen figured in Plate G, figs. 1 and 1 *a*, of the "Fauna Antiqua Sivalensis" with the specimen figured in Plate XI of this memoir; as before said, a copy of the frontal view of Falconer's specimen is given in Plate XXII, fig. 4, of the "Palæontological Memoirs," and the occipital view is given in the plates accompanying the present memoir (*Plate XVI, fig. 3*).

In the accompanying index to the plates, Dr. Falconer refers to the specimen in the following words: "Fragment of cranium, showing forehead, occiput, occipital condyles, and foramen magnum; portion of right horn, and core of left horn. The specimen shows well the flat square forehead, the height being about equal to the breadth. The horns are attached to the extremities of the highest salient line of the head; the horn-cores spread out horizontally, with a slight arch upwards

and concavity below. The section of the horn-core is much more circular than in the Gour or Gayal."

The frontal view of this specimen is distinguished from that of the cranium figured in Plate XI by the intercornual ridge being perfectly straight, instead of being raised into a median prominence, and by the contraction between the orbit and the horn-core being deeper and shorter, the frontals being thereby more nearly square; the horn-core seems to be shorter and with a sharper curve forwards.

On the occipital aspect (*Plate XVI, figs. 1 and 3*) the two specimens present more striking differences; in Falconer's specimen the superior curved line extends upwards between the base of the horn-cores, and the indentations of the temporal fossæ are consequently considerably below the summit of the curved line, instead of nearly on a level with it, as in our specimen; the intercornual arch is also nearly straight in Falconer's specimen and arched in ours; finally, the vertex of Falconer's specimen very slightly overhangs the plane of the occipital condyles, while it does so considerably in our specimen, though not to any great extent in the position in which the specimen is figured. I consider that the difference in the form of these two crania is chiefly due to age, the high and projecting intercornual ridge of the specimen in the Indian Museum being caused by a great development of the intertabular cancelli: the horn-cores, however, must originally have been placed somewhat higher in relation to the curved line of the occiput than in the British Museum specimen: as before said, the specimen figured in Plate G, fig. 2, of the "Fauna Antiqua Sivalensis," agrees exactly in form with the specimen figured in Plate XI of the present memoir, so that the two varieties were classed together by Dr. Falconer.

In addition to all the above-mentioned specimens, the Indian Museum also contains several crania of much smaller oxen from the Nerbudda valley, which, however, belonged to adult animals, and which have the same general characters as the larger crania of *Bos namadicus* from the same deposits; these smaller crania, I think, belonged to female individuals of the above species, the skulls described above being those of males; although there is a very great difference in the size of these skulls, yet I think the difference is very little, if at all greater, than occurs between the crania of male and female individuals of the existing *Bibos banting.* The measurements of the most perfect of these smaller crania are given below; the proportion of the antero-posterior diameter of the forehead to the transverse will be found in the table given below; from this it will be seen that the proportionate excess of the antero-posterior diameter over the transverse diameter is nearly the same as in the larger crania; the following are the measurements:—

Width at superior border of orbits	5·8
„ at constriction below orbits	6·3
„ at constriction above orbits	6·5
Length from intercornual ridge to apex of nasals	9·5
Antero-posterior diameter of left orbit	2·6

Transverse diameter of left orbit	2·2
Length of temporal fossa	5·3
Interval between base of horn-core and orbit	3·4
Height from lower border of foramen magnum to occipital crest	4·5
Interval between occipital crest and intercornual ridge	2·0
Length of intercornual ridge	6·2
Interval between exterior angles of occipital condyles	3·8
Width of occiput between temporal fossæ	4·7
Antero-posterior diameter of base of horn-core	2·5
Transverse ditto ditto	2·4
Circumference of ditto	6·0
Width of palate	3·8
Interval between outer surfaces of second molars	5·2
Length of six molars	5·5
„ of last molar	1·4

The frontals of the above specimen differ from those of the larger crania by being rather more concave in the middle line, and by having a sharp ridge nearly half an inch in height running along the frontal suture for the attachment of the frontalis muscle. The intercornual ridge forms a high convex arch overhanging the plane of the occiput, when the skull is placed horizontally; the horn-cores have an almost completely circular cross-section; the general form of the whole occipital surface agrees exactly with that of the large Nerbudda specimen described above; the line of the molar series is nearly straight; the costæ on the external surfaces of the molars are prominent and of nearly equal height; the accessory column on the inner side of the molars is large, with a constricted neck. The dimensions of a detached horn-core of the female from the Nerbudda valley are as follows:—

Circumference at base	9·5
Length along upper curvature	10·4

This horn-core is perfectly cylindrical, is greatly curved, and tapers very rapidly from base to tip: another fragment of a larger horn-core in the Indian Museum has a deep and wide groove running along the concave curvature, and continuing almost to the tip; I have not seen a similar groove in any other specimen.

Fragments of the cranium and teeth of this species have been brought by Mr. Fedden from the older alluvium of the Perim-ganga River in the Hyderabad district; remains of the species were also determined by Dr. Falconer from the older alluvium of the Jumna; both deposits being probably near the horizon of the Nerbudda gravels.

Dr. Falconer suggested that the cranium of the typical *Bos namadicus* bore a considerable resemblance to that of the European *Bos primigenius;* a comparison of the two crania, however, shows considerable differences; for this comparison we may refer to a figure of the frontal aspect of the cranium of *Bos primigenius* given in Professor Owen's "British Fossil Mammals and Birds" (*p. 498, ed. 1847*).

The crania of the two species are characterised by having long and flattened frontals, which considerably exceed in length the facial portion of the skull; in both crania the nasals are long and tapering; they are, moreover, slightly arched, and are wider at their infra-orbital angles than elsewhere; in both the horn-cores are approximately cylindrical, and extend far in front of the face, while the orbit is separated by a long interval from the base of the horn-core; the cranium of *Bos namadicus* is, however, somewhat narrower above the orbits than that of *Bos primigenius*, in consequence of being more deeply excavated laterally. In the figured specimen of the cranium of *B. namadicus* the intercornual space is arcuated, whereas it is straight in *B. primigenius;* the horn-cores in the crania of both species are placed on the frontals in a very similar manner, but those of the Indian species are larger and longer, and their direction is more upwards; moreover, they have no double curve, and their terminal curve is sharper than in *Bos primigenius.* The variety of *Bos namadicus* from the Nerbudda, in which the horn-cores have an ellipsoidal cross section, differs still more from *Bos primigenius* and approaches to *Bibos.* The nasals of *B. primigenius* articulate with the premaxillæ, while those of *B. namadicus* do not.

The occipital region of the specimen of *Bos namadicus* figured in Plate XI I have compared with the corresponding surface of a cranium of *Bos primigenius* in the Indian Museum, and have found very striking differences between the two. The occiput of *Bos primigenius* has the form of that of a typical species of the genus, being characterised by its general quadrangular outline and by the absence of any indentation of the lateral boundaries of this surface by the extremities of the temporal fossæ; the occipital crest or superior curved line is flattened at its summit, and its lateral borders are approximately straight; marked angles are consequently formed at the junction of the lateral and superior borders of the infra-cristal portion; there is a large shield-like protuberance for the insertion of the ligamentum nuchæ, and the summit of the occipital crest reaches upwards as far as the middle of the bases of the horn-cores; between the occipital crest and the base of the horn-core there is a smooth hollow surface. The paroccipital processes are large, angular, and prominent, and there is a wide space on their outer surfaces for the attachment of the digastric muscles; the interval between the external angles of the occipital condyles is equal to half the interval between the posterior extremities of the temporal fossæ, is much less than the interval between the inferior border of the foramen magnum and the summit of the occipital crest, and is less than half the width of the occiput measured through the foramen magnum; finally, the supra-cristal portion of the occiput does not overhang the infra-cristal portion, and the plane of the occiput consequently is nearly straight, or slightly convex.

In the cranium of *Bos namadicus,* on the other hand, we find the occipital surface (Plate XVI, fig. 1) indented laterally by the extremities of the temporal fossæ, and the quadrangular outline of the occiput consequently lost; the occipital

crest forms an unbroken regular curve; its summit does not extend upwards to the middle of the base of the horn-cores, and consequently the supra-cristal portion of the occiput is of considerable height; moreover, the latter portion projects backwards so as to overhang the plane of the infra-cristal portion of the occiput, and the plane of the whole occiput is consequently concave from above downwards. The ligamentum nuchæ seems to have been inserted on a flat surface and not to a tubercle; the paroccipital processes are broad and rounded, and the surface for the digastric muscle is narrow. The interval between the external angles of the occipital condyles is only slightly less than the interval between the inferior border of the foramen magnum and the occipital crest, the same interval is greater than half the width of the occiput measured through the foramen magnum, and is equal to two-thirds of the length of the interval between the extremities of the temporal fossæ; finally, the intercornual crest is often arcuated.

The cranium of *Bos namadicus* therefore differs from the cranium of *Bos primigenius* in the following points: the short premaxillæ, which do not reach the nasals; the low position of the occipital crest relatively to the horn-cores, the arcuated intercornual ridge, the intrusion of the temporal fossæ on to the occiput, the concave plane of the latter, and the regular curve of the occipital crest; in almost all these points, in which the cranium of *Bos namadicus* differs from that of *Bos primigenius*, it approaches to the crania of the genus *Bibos*.

The peculiar forward curve of the horn-cores of this species, as is well shown in the profile view, presents considerable resemblance to the curve of the horn-cores of the yak; this, however, cannot be taken as of any importance in showing kinship between the two animals, as the forms of the crania of the two are so entirely different.

We have now to consider in what manner the cranium of the present species differs from those of the two Indian species of *Bibos*. If we refer to the table of frontal measurements given below, it will be found that the antero-posterior diameter of the forehead of this species exceeds the transverse diameter by one and a half inches, whereas in the forehead of *Bibos* the transverse diameter is the longer of the two.

In typical crania of this species the transverse section of the horn-core is either circular or approximately circular; and the horn-cores are placed on the highest ridge of the skull, which is situated immediately above the proper occipital surface; the base of the horn-core is separated by a long interval from the orbit; and the skull between these two points is considerably contracted in width. The length of the frontal portion of the cranium considerably exceeds that of the facial portion, while the orbits are salient and placed on a level with the frontals, and the nasals are long and widest at their infra-orbital angle.

On the other hand, in the genus *Bibos* the horns of the males are laterally compressed, and their uppermost border is concave (the same border of the horn-cores of *B. namadicus* being convex close to the skull): the bases of the horn-cores

and the orbits are closely approximated; the cranium of *Bibos gaurus* is but slightly contracted in width between these two points, while that of *Bibos frontalis* is not contracted at all in the same place; the orbits of the former species are non-salient, while those of the latter are considerably depressed below the plane of the frontals. The nasals of both species are wider at their free distal extremities than at their infra-orbital angles, while those of *Bibos frontalis* are further distinguished by their extreme shortness: finally, the length of the facial portion of the cranium in both species is equal to that of the frontal portion.

If now we compare together the occipital surfaces of the three crania, we shall find still more striking and marked differences between that of *Bos namadicus* and those of *Bibos*. Figures of the occiput of *Bos namadicus* are given in the present memoir (*Plate XVI, figs. 1, 3*); and figures of the same region of the crania of *Bibos gaurus* and *Bibos frontalis* will be found in Mr. Hodgson's paper on the genera of Indian cattle.[1]

Turning firstly to the occiput of *Bibos frontalis,* we find this surface of the skull divided into two distinct portions; inferiorly there is the proper occipital or infra-cristal surface roughened for muscular attachments; and superiorly the smooth parieto-frontal or supra-cristal surface situated between the bases of the horn-cores. At the junction of these surfaces the occiput is deeply indented from either side by the temporal fossæ—so deeply that the intervening surface of the parietals is but very slightly, if at all, wider than the interval between the external angles of the occipital condyles. These temporal fossæ are wide, and a portion of their inner termination on the occipital surface is situated above the summit of the occipital crest; while the latter is placed below the lower border of the base of the horn-cores. The interval between the external angles of the occipital condyles is precisely equal to that between the lower border of the foramen magnum and the summit of the occipital crest, and is equal to one-half the width of the widest part of the occipital surface; and, as stated above, is very nearly equal to the interval between the temporal fossæ. Below the summit of the occipital crest there is a large shield-like protuberance for the attachment of the ligamentum nuchæ. The intercornual ridge is wide and straight.

The occiput of *Bibos gaurus* agrees in form and comparative measurements with that of the last species, with the exception that the intercornual ridge is produced forwards between the horns in a high arch, so that the vertical height of the supra-cristal portion of the occiput is greater than that of the infra-cristal portion.

On the other hand, the occiput of *Bos namadicus* has a totally different form from either of the above. The temporal fossæ make but very small indentations on to the occiput, and consequently this surface is not so distinctly divided into two portions. The indentations of the temporal fossæ being so small, the summit of the occipital crest is placed considerably above them, and extends upwards beyond

[1] Journal of the Asiatic Society of Bengal, Vol. X, p. 470.

the lower borders of the horn-cores; consequently the interval between the extremities of the temporal fossæ is far larger than that between the external angles of the condyles; the same interval also is considerably less than that between the lower border of the foramen magnum and the summit of the occipital crest, and is equal to more than half the width of the widest part of the occiput. There is no marked prominence below the occipital crest for the attachment of the ligamentum nuchæ; and the supra-cristal portion of the occiput considerably overhangs the infra-cristal portion; the intercornual ridge is slightly arcuated. Finally, as a character of minor value, the directions of the horn-cores are quite different; those of *Bos namadicus* have a graceful very open curve, the first turn of which has the superior border convex; in *Bibos* the horn-cores have but one slight curve, and their upper border is concave. The anterior border of the orbits in *Bos namadicus* is very nearly parallel with the long axis of the cranium, and the axis of the orbit is directed outwards; in *Bibos* the same border of the orbit is placed obliquely to the long axis of the cranium, and the axis of the orbit is directed downwards and outwards. There can therefore be no doubt as to the distinctness of the Nerbudda ox from the genus *Bibos*. In one point, however, the cranium of *Bos namadicus* differs from those of more typical species of the genus, and thereby approaches to the cranium of *Bibos;* this point is the relation of the premaxillæ to the other bones of the face. In his definition of the restricted genus *Bos*, as given in the first Catalogue of the *Ungulata* in the British Museum (*1853*), the late Dr. Gray says that the premaxillæ are large and always extend upwards into the triangular space between the maxillæ and the nasals, and consequently articulate with both these bones, in the same manner as in the genus *Bubalus;* in the genus *Bibos*, on the other hand, the premaxillæ are small, and are attached only to the distal extremities of the maxillæ, and are separated by a considerable interval from the nasals. In the second Catalogue of Ruminants in the British Museum (*1873*), however, Dr. Gray has added a new species of *Bos*, namely, the *Bos chinensis* of Mr. Swinhoe, which vitiates the above distinction between *Bos* and *Bibos*, though no mention of this fact is made in the Catalogue. We may refer to a figure of the cranium of the Chinese species, which is undoubtedly a true *Bos*, given in the Proceedings of the Zoological Society of London for 1870, and we shall then find that the premaxillæ are small, and do not extend upwards to the nasals, precisely as in *Bibos*.

In our figured cranium of *Bos namadicus*, the distal portion of the face has been in great part broken away, so that the relations of the different bones cannot be well observed; on the right side of the specimen, however, a minute portion of the proximal extremity of the premaxilla still remains; this is situated near the extremity of the maxilla, and is far removed from the nasals, precisely as in *Bos chinensis* and in *Bibos;* other less complete specimens of the cranium of *Bos namadicus* in the Indian Museum show this relation more clearly. The above facts, therefore, compel us to abandon one of Dr. Gray's distinctions between *Bos* and *Bibos* as not being applicable to all the species. It is noteworthy that the short premaxillæ

which occur in the Indian genus *Bibos* also occur in two Asiatic species of the genus *Bos* and in no others.

The nasals of *Bos namadicus* are widest at the angle immediately below the orbit, while below this angle they diminish in width regularly to their distal extremity; in *Bibos*, on the other hand, and in most species of *Bubalus*, the infra-orbital angle of the nasals is not their widest part; in *Bibos gaurus* the nasals at first slightly contract below this angle, and then spread out again to a greater width than at any other part: in *Bibos frontalis* the extremely short nasals preserve an almost uniform width throughout their length. The figured cranium of *Bos namadicus* also agrees with that of *Bibos gaurus* in having an arcuated intercornual space, but this character is not universal in the former species.

In the Collection of the Indian Museum we have a large series of limb-bones of oxen from the Nerbudda valley, but it is generally impossible to say whether they belong to *Bos namadicus* or to *Bubalus palæindicus:* the only bones I will mention here are some specimens of the metacarpals and metatarsals, which from their resemblance to the bones of *Bos primigenius* may, I think, have belonged to the Nerbudda ox. The metacarpal is strong and stout; on the anterior surface there is a slight, though distinct, groove for the extensor tendons, which does not, however, extend far above the nutrient foramen; the middle of the anterior aspect presents a smoothly rounded surface, without any distinct ridges; the posterior surface is quite flat, with no median hollow for the flexor tendons; the articular surface for the unciform is of very small size, the division between this surface and that for the trapezo-magnum being placed on the outer side of the median line. The dimensions of the specimen are—

Extreme length	9·5
Transverse diameter of carpal surface	2·6
Antero-posterior diameter of surface for trapezo-magnum	1·6
Transverse diameter of two trochleæ	2·8
Circumference of shaft at middle	5·0

The specimen exactly agrees in length with the metacarpal of a large male Gour in the Indian Museum; the metacarpal of the latter species is, however, more slender, and has a well-marked extensor groove throughout its length. The bone is half an inch shorter than the metacarpal of *Bos primigenius* described by Professor Owen in his "British Fossil Mammals and Birds," and is 1·3 inches less in circumference, indicating that the Nerbudda ox was of slighter build than the English Pleistocene ox: in fact, intermediate in this character between the latter and the Indian Gour.

The metatarsal which I refer to this species is characterised by presenting a nearly square cross section at its centre: at its proximal extremity it becomes slightly expanded in an antero-posterior direction, while at the distal extremity the transverse diameter becomes considerably the longer of the two. On the anterior surface there is a wide and deep groove for the extensor tendons. The trochleæ are

separated by a wide interval: on the posterior surface the bone is flattened and has no distinct flexor groove; the whole length of the bone is equal to four-and-a-half times the transverse diameter of the two trochleæ; its dimensions are as follows:—

Length	11·15
Transverse diameter of two trochleæ	2·60
Circumference at middle of shaft	4·80

This specimen would correspond in proportionate size with the metacarpal noticed above: in *Bos primigenius* the metatarsal is 1·3 inches larger than the metacarpal; and the former bone is very like this specimen in form and size; it is slightly longer than that of the Indian species.

The flat-horned variety of *Bos namadicus*, as I have before said, differs from type species of the genus *Bos*, and agrees with the genus *Bibos*. We have already noticed various other points of resemblance between the Nerbudda ox and the latter genus, and since there is now no wild Taurine ox living in India, and as the genus *Bibos* must have lived almost immediately after the extinction of the Nerbudda species, and is at present unknown during the period in which that species lived, it may, I think, be a fair inference that the one is the direct ancestor of the other; or that, in any case, both have sprung from one common stock. If I am right in considering the next described species of flat-horned ox from the Siwaliks as the ancestor of *Bos namadicus*, we are enabled to trace the probable ancestry of the Gour and Gayal backwards to the Siwalik period, and to mark their gradual divergence from the true Taurine type. I hope that Zoologists and Geologists in India will give particular attention to collecting any remains of Mammals that may occur in the upper Pleistocene and early recent beds of India, in order that we may be enabled to trace the earlier species more directly up to the present species, and to discover intermediate forms such as I presume must have existed between *Bos namadicus* and *Bibos gaurus*.

The Nerbudda ox, owing to the discovery of a palæolithic implement by Mr. Hacket in the beds in which its remains occur, was at all events, during a certain portion of the period in which it existed, a contemporary of the early human inhabitants of India; and the genus *Bibos*, if we adopt the view that it is descended directly from *B. namadicus*, must also have acquired its characteristic modifications of cranium within the same period. Whether man was instrumental in causing the final disappearance of the Nerbudda ox, or whether it was unable to compete against the modern oxen, or whether the disappearance of the sâl forests from the Nerbudda valley, which Captain Forsyth in the "Highlands of Central India" considers as the cause of the disappearance of *Bubalus palæindicus* from that district, was fatal to the existence of *Bos namadicus*, we are at present unable to decide; but I am inclined to think that the second of the three hypotheses is the more probable.

Bos planifrons, n. sp. *nobis*. Pl. 12, f. 2; Pl. 16, f. 4.

The specimen figured in the above-mentioned plates consists of an upper part of the frontlet with the greater part of the horn-cores of a species of *Bos* distinct from the last species; the specimen was collected in the Siwaliks of the Punjáb by Mr. Theobald. On referring to the table of measurements on page 66, it will be seen that the antero-posterior diameter of the forehead of this species is longer than the transverse diameter, while if we turn to the view of the occipital surface (*Plate XVI, fig. 4*), we shall see that the horn-cores are placed upon an elevated ridge immediately over the occiput, that there is no distinct parietal band across the back of the cranium, and that the frontals are nearly flat; the transverse section of the horn-cores is somewhat elliptical, and the occiput is squared and but slightly indented laterally by the terminations of the temporal fossæ. All the above characters clearly show that the specimen should be referred to the restricted genus *Bos*, although the elliptical cross section of the horn-cores differs from type species of that group.

The above characters also sufficiently distinguish our specimen from the living genus *Bibos;* the direction of the horn-cores sufficiently distinguishes it from *Bos namadicus,* since in the present specimen the horn-cores are directed almost immediately outwards, with a slight tendency upwards and inwards, and they do not curve forward as in *Bos namadicus.* In the latter species the tips of the horn-cores of the figured specimen are about two feet in advance of the plane of the frontals, whereas in *B. planifrons* the horn-cores where broken are not more than three inches in advance of the same plane. The occipital surfaces of the two type forms are also slightly different, that of the Siwalik species being more strictly Taurine.

As is shown in the figure of the forehead, the frontals are longitudinally fissured in our specimen, the parts on each side of the line of fracture being somewhat laterally compressed, so that the median line of the frontals is thrown forwards in advance of its proper plane, thereby causing the forehead to appear more convex than it naturally would be. In the unbroken condition of the frontals these bones would be very nearly flat between the horn-cores; below the bases of the horn-cores, the median line of the frontals becomes somewhat more prominent, and the lateral surfaces slope away on either side, so that the anterior border of the orbit is placed somewhat below or behind the median line of the frontals. The lateral surfaces of the frontals are marked by supra-orbital sulci of great width and depth, which converge together as they descend: there are no distinct supra-orbital foramina in the specimen; this is, however, probably only an individual peculiarity. The lateral contraction of the forehead between the base of the horn-core and the orbit is distinct, though of no great length; the re-entering angle for the insertion of the apex of the nasals is seen on the lower border of the figure; it does not extend upwards as far as the centre of the orbits.

The lower and left portions of the occipital surface have been broken away in our specimen; the occipital crest forms a very wide and flattened arch, somewhat prominent and separated by an oblique groove from the base of the horn-core of either side: the smooth surface above the occipital crest is concave from side to side and slightly convex from before backwards; it overhangs to a very slight extent that part of the surface of the occiput below the crest. The portion of the occiput below the crest or curved line is deeply marked by ridges and hollows for muscular attachments; a deep pit is seen on the right hand of the figure for the attachment of the recti-capitis muscles. The bases of the horn-cores are separated from each other by a considerable interval; the ridge occupying this interval is slightly convex when viewed from behind; in a front view the same ridge is either straight or very slightly concave, according to the position of the skull, but never convex. The horn-cores themselves are at first directed outwards, upwards, and a little forwards; they are continued in a single unbroken curve as far as those of our specimen extend; they certainly when complete had not the double curve of the horn-cores of *Bos primigenius*, neither were they extended forwards or bent upwards towards the tip as in the Nerbudda species. At their junction with the frontals the horn-cores expand suddenly both above and below, the areas of their transverse section being here greater than those of the portions of the frontals to which they are attached; the summit of the curved line of the occiput extends far upwards between the bases of the horns, and consequently is far removed from the extremities of the temporal fossæ; these latter form wide but shallow fissures on the occiput. The transverse section of the horns is laterally compressed. The dimensions of the specimen are given below:—

Width at superior border of orbits	9·3
„ constriction above „	8·8
Length from intercornual ridge to apex of nasals	10·2
„ of intercornual ridge	7·0
Interval between occipital curved line and intercornual ridge	2·0
Width of occiput between temporal fossæ	6·7
Circumference of base of right horn-core	14·5
Length of remaining portion of „	19·0
Circumference of right horn-core at fracture	9·0
Antero-posterior diameter of right horn-core	4·5

We have now to compare this cranium with our specimens of the crania of *Bos namadicus*. We will first compare it with Falconer's specimen of the latter species already so often referred to. In the figures of the occipital regions of the two specimens (*Plate XVI, figs. 3 and 4*), the cranium of the Siwalik species (*fig. 4*) has the occiput placed more vertically than in Falconer's specimen (*fig. 3*); in consequence of this the crest or curved line of the occiput of the latter appears to be placed lower down than in the former specimen.

On the frontal aspect the intercornual ridge of the Siwalik species is slightly concave instead of straight or convex, while the lateral indentations of the skull

between the horn-cores and the orbits are rather less deep, and the centre of the forehead is rather more prominent: the horn-cores tend more directly outwards with only a very slight curve forwards. On the occipital aspect the chief difference is that the vertical diameter of the infra-cristal portion is considerably greater in proportion to the transverse diameter in the Siwalik species; this gives the whole occiput a more quadrate appearance, by which it approaches, as before said, more closely in form to the occiput of the true Taurine oxen, like *Bos primigenius.* The occiput of Falconer's Nerbudda specimen forms a transition from the Siwalik species to the occiput of our large Nerbudda specimen (*Plate XVI, fig. 1*), in which the long transverse diameter of the occiput and the separation of the infra-cristal portion of the same surface is a character approaching to the occiput of *Bibos*. The occipital crest of our specimens of the Nerbudda species (*Plate XVI, figs. 1 & 3*) is completed in a single simple curve, whereas the proper occiput of the Siwalik species has high lateral borders at first scarcely curving at all, and with marked angles at their junction with this superior border; the indentations of the temporal fossæ on to the occiput are very shallow and are placed much below the level of the summit of the occipital crest or curved line. In the Nerbudda species, these indentations are somewhat larger, and are placed nearer to the level of the occipital crest: in all the above characters Falconer's specimen of *Bos namadicus* is intermediate between the Siwalik cranium and the typical Nerbudda crania.

In the Indian Museum there is another similar frontlet of an ox (No. 141), also collected in the Siwaliks by Mr. Theobald, which I refer to the same species as the last specimen, though it presents some slight differences in form. The specimen comprises only the intercornual portions of the frontals, with the upper part of the occiput and the bases of the horn-cores. The dimensions are as follows:—

Length of intercornual ridge	7·2
Interval between occipital crest and intercornual ridge	1·8
Width of occiput between temporal fossæ	7·0
Circumference of base of horn-core	14·5

These few measurements agree nearly with those of the last specimen: the cross section of the horn-cores, however, exhibits a more nearly circular form, though the horn-cores themselves are directed upwards and outwards, with no inclination forwards. The occipital surfaces of this and the last specimen are almost identical in form, the curved line or crest extending high up between the horn-cores; in the second specimen, however, the intercornual ridge is raised up into a median prominence, as in the figured specimen of the Nerbudda species.

We may now compare the cranium of this Siwalik species with that of the European *Bos primigenius* in order to see in what points it differs from that most typical form of Taurine Oxen. Turning first to the occipital surfaces of the two crania, we shall find that the occiput of the Siwalik species is much more close to the European form than is the occiput of *Bos namadicus.* In both the European and the Siwalik crania, the summit of the occipital crest extends high up between

the bases of the horn-cores; in both, the general outline of the occiput is approximately quadrangular, while the indentations of the temporal fossæ on to the latter surface are of very small extent in the Siwalik speeies, and are almost entirely wanting in the European species. The occipital surfaces of the two forms are, however, broadly distinguished by the greater relative length of the transverse diameter in *Bos primigenius.* The summit of the occipital crest in the Indian cranium is not flattened to the same extent as in the European cranium, and is separated by only a small interval from the intercornual ridge. The foreheads of the two species have nearly the same general proportions, but that of the Indian species is distinguished by being slightly convex. We are unable to tell whether the relations of the premaxillæ to the nasals in *Bos planifrons* are similar to those which occur in *Bos primigenius* or to those which occur in *Bos namadicus* and *Bibos.*

The horn-cores of the Siwalik species present an elliptical cross section, and thereby differ very markedly from the European species, in which the horn-cores are cylindrical; in the same degree they approach the horn-cores of the flat-horned variety of *Bos namadicus* and *Bibos.*

The proportions of the frontals in *Bos planifrons,* the general form of the occiput, and the small size of the indentations of the temporal fossæ on that surface, show that this species was nearer to the true Taurine Oxen than any other living or fossil species of Indian Ox. As I have before said, however, the occiput of Dr. Falconer's so often quoted variety of *Bos namadicus* is intermediate in form between the occiput of the typical variety and that of *Bos planifrons:* this, together with the fact that the occurrence of flattened horns is a character common to *Bos planifrons* and to some varieties of *Bos namadicus,* and from a certain general resemblance in the form of the crania of the two species, induces me to think that the latter may very possibly be the direct descendant of the former.

Bos ACUTIFRONS, n. sp. *nobis.* Plate 12, fig. 1; Plate 13; and Plate 16, fig. 2.

The cranium of this magnificent species has been already shortly noticed and named by me in the tenth volume of the "Records of the Geological Survey of India." The cranium in question was discovered in 1874 by Mr. Theobald in the Siwaliks of the Punjáb.

In the accompanying plates I have given two views of the frontal aspect of this cranium, one on a larger scale showing the frontlet and a portion only of the horn-cores, and the other the whole of the specimen on a much smaller scale. On Plate 16, figure 2, I have also given an occipital view of the same specimen. When brought to the Indian Museum the horn-cores were broken into numerous fragments, and the specimen was coated with the tightly-adhering grey Siwalik sandstone. The matrix has now been cleared away, and the specimen mounted as shown in the

smaller figure. The greater part of the horn-cores are complete, though they have both lost their extremities; almost the whole of the frontals are also remaining and are in excellent preservation; the left orbit is entire, together with the right temporal fossa, and the greater part of the zygomatic arch of the same side. The whole of the lower part of the face below the apex of the nasals has unfortunately been completely broken away; the occipital region has been also considerably damaged, but its characteristic upper boundaries are fortunately preserved; the occipital condyles have disappeared, and the borders of the foramen magnum and the surrounding portions of the occiput are somewhat broken and crushed; the basi-occipital and the sphenoidal regions are uninjured.

In the general form of the forehead this cranium is quite unlike that of any other described species of recent or fossil Oxen; in its general characters, however, it appears to approach nearest to the restricted genus *Bos*, although its differences are such that we might very readily refer the species to a distinct sub-genus, were it not that the multiplication of these smaller groups is extremely undesirable.

The frontals are produced mesially into a very prominent longitudinal ridge, which extends from the vertex of the cranium to the apex of the nasals; from the presence of this very characteristic ridge, I have assigned to the specimen its specific name of *acutifrons*. From this central ridge the frontals slope away on either side, backwards and outwards, like the two sides of a roof, and the forehead has in consequence two distinct planes. From this peculiar configuration of the frontals, the anterior borders of the orbits are necessarily placed greatly below or behind the median line of the forehead, so that if a horizontal rod be laid across the frontals above the centre of the orbits, the anterior borders of the latter will be found to be more than two inches below or behind this rod, whereas in no recent species of Oxen would the same border of the orbit be more than half an inch below a similarly situated rod.

The above-mentioned median frontal ridge, commencing at the highest point of the cranium, is continued directly downwards as a single and sharp line as far as the superior border of the orbits, at which level it expands into a broader ridge, which embraces the apex of the nasals; the orbit of either side is separated from this median ridge by a wide v-shaped channel, which expands as it descends on the face; this channel is a downwards continuation of the supra-orbital sulcus, and is quite unlike the sulcus of any other species of Oxen; the broad notch for the insertion of the apex of the nasals is seen on the lower border of the figure; this notch does not extend higher up on the skull than the level of the inferior border of the orbits.

The horn-cores are placed on the highest ridge of the cranium, immediately above the occipital surface; they are set very obliquely on the forehead, so that the interval between their inferior angles is nearly twice the length of the interval between their superior angles; in a transverse section throughout half their extent the horn-cores are pyriform, the apex of the pear being upwards; in consequence of

this form the superior border of the horn-core is produced into a distinct and sharp ridge; several deep grooves, to receive ridges on the inner surface of the horn, run parallel to the superior ridge. The second half of the horn-core (*Pl. 12, fig. 1, a*) is nearly cylindrical; throughout its length the inferior surface is rounded and smooth; there is a slight "burr" at the junction of the horn-cores with the frontals. The direction of the long horn-cores is at first upwards, outwards, and backwards; towards the middle of their course their direction becomes backwards and downwards, while towards their extremities it becomes forwards and downwards; they never extend far in advance of the plane of the frontal-ridge; throughout their length their upper border is convex, while their lower border is concave.

The anterior surface of the base of the horn-core is continued outwards and backwards as an extension of the surface of the frontal of the same side, both having the same slope; in consequence of this the central point of the upper half of the frontals is the most prominent point of the whole cranium.

A long interval separates the orbit from the base of the horn-core of the same side; between these two points the cranium is considerably contracted in width; the orbits themselves are laterally salient, and quite circular; their anterior border is parallel with the long axis of the cranium, as seen on the right side of the figure; the direction of their axis seems to be directly outwards.

Turning to the view of the occipital surface (*Pl. 16, fig. 2*) we find this portion of the skull very different from that of any other Bovine; which difference might be taken as a reason for placing the species under a new sub-genus. The occipital crest or superior curved line forms a very high narrow arch, which extends upwards to within a short distance of the vertex cranii, so that the supra-cristal portion of the occipital region is reduced to a very narrow band; this supra-cristal portion is not carried upwards directly in the plane of the supra-cristal portion, but is rounded off in front to join the frontals. A smooth, slightly concave surface, separates the lateral boundaries of the occipital crest from the bases of the horn-cores; the occipital crest overhangs the true occipital surface to an extent of nearly an inch. The whole of the occipital surface below the crest forms a rude triangle with curvilinear boundaries. On the occipital surface the temporal fossæ form narrow triangular slits beneath the horn-cores: these slits are directed upwards and inwards, and are situated far below the summit of the occipital crest. The bases of the occipital condyles, the condyles themselves being broken away, are seen at the lower part of the figure: the upper part of the foramen magnum has also been broken away, and therefore the foramen appears to be placed higher on the occiput than it naturally should be. The paroccipital processes are large and recurved: the space for the attachment of the digastric muscle, external to the paroccipital, is narrow and long.

Turning to the table of frontal measurements on the following page, we find that the antero-posterior diameter of the forehead exceeds the transverse by a considerable length. The plane of the occiput forms an acute angle with that of the centre

of the frontals. The basi-occipital is triangular, and characterised by the very large size of the posterior pair of tubercles, and the small size of the anterior pair.

The dimensions of the specimen are given below :—

Interval between occipital crest and intercornual ridge	1·8
Width at superior border of orbits	11·0
„ at constriction above orbits	8·7
Height from lower border of foramen magnum to occipital crest	5·8
Distance from occipital crest to apex of nasals	13·0
Length of intercornual ridge	5·0
Width of occiput through petrosals	11·4
Interval between extremities of temporal fossæ	6·2
„ between orbit and base of horn-core	4·0
Antero-posterior diameter of left orbit	2·6
Transverse „ „	2·4
Length of temporal fossæ	5·8
Antero-posterior diameter of left horn-core at base	6·0
Transverse „ „ „	4·1
Circumference „ „ „	17·0
„ „ „ at broken extremity	7·0
Length of ditto along upper curvature	49·0
„ „ lower ditto	39·0
Interval between broken extremities	87·0

From the above description it will be gathered that the present cranium presents a combination of characters which render it difficult to assign it to any one of the recent genera of *Bovina,* without infringing on their definitions. The form of the occiput is, however, sufficient to distinguish it at once from *Bibos* and *Bubalus* by the high position of the occipital crest and the small size of the indentations of the temporal fossæ; it is also separated from the latter genus by the acute angle which the plane of the occiput makes with that of the frontals. In the following points the present specimen agrees with the cranium of *Bos* :—

The acute angle formed by the planes of the frontals and occiput.

The position of the horn-cores on the highest ridge of the skull, directly above the plane of the occiput.

The excess of the antero-posterior over the transverse diameter of the forehead.

The small intrusion of the temporal fossæ on to the surface of the occiput.

The long interval between the base of the horn-core and the orbit.

The parallelism of the anterior border of the orbit with the long axis of the cranium.

The convexity of the upper curve of the horn-cores.

On the other hand, it differs from all other species of *Bos* in the peculiar convexity of the frontals. Professor Owen made the flatness of the forehead a distinctive character of the genus; this, however, is not taken as a character by Dr. Gray in his Museum catalogue, since the forehead of the Indian Ox is slighly convex, and is yet admitted into the genus *Bos.* Moreover, in the above-mentioned Siwalik species of Ox, *Bos planifrons,* the frontals are also slightly convex, although in other charac-

ters that species agrees very closely with typical forms of *Bos,* and cannot be separated from that genus. From the convexity of the frontals in that species, the orbits were of necessity somewhat depressed below the plane of the median line, though not to the same extent as in the present species. With regard, therefore, to the convexity of the frontals, I cannot consider this character if taken alone, as sufficient cause for subgeneric distinction. Again, with regard to the form of the occipital surface, Mr. Hodgson[1] in his Memoir on the genera of Indian cattle, describes the occiput of the genus *Bos* as not being indented by the temporal fossæ; this, however, as we have seen in the instance of the Nerbudda *Bos namadicus,* is not universally the case, and therefore not of generic value. The small size of the indentations, however, and their position, does appear to be of value. Looking at the position of the occipital crest and the indentations of these fossæ in the present specimen, and comparing them with the crania of other figured species of the Oxen, we can only find any resemblance to the occiput of our species among the crania of the restricted genus *Bos.* At the same time, in no other species does the crest extend so high up on the occipital surface, or possess the same triangular shape, as in the present species; if, however, the summit of the occipital crest of *Bos namadicus* formed a somewhat higher arch, and were consequently narrower, then the form of the occiput in the two species would not be so very dissimilar. The occipital crest of this species overhangs the infra-cristal surface of the occiput in a manner only found among the species of the restricted genus *Bos;* the rounding-off of the supra-cristal portion of the occiput is a character approaching the Bubaline type, but the other characters do not bear this out. The basi-occipital is very similar to that of *Bos taurus.*

The approximation of the superior angles of the bases of the horn-cores is a character which, though not belonging to the genus *Bos,* is equally divergent from the same part in any other genus, though there is an approach to it in the fossil *Bubalus platyceros* described below; this, however, is not a character of much value in generic distinctions, being one which varies considerably with age even in individuals of the same species. The position of the apex of the nasals at the lower border of the orbit is a minor characteristic of the cranium of *Bos.*

Taking the interval between the external angles of the occipital condyles of the typical form of *Bos namadicus* as a standard of comparison, we find that this interval falls considerably short of half the width of the occiput measured through the foramen magnum, and is also less than the interval between the lower border of the foramen magnum and the summit of the occipital crest, showing that the occiput is both narrower and higher than in other forms. On comparing the measurements of this specimen with those of *Bos namadicus,* given above, we find that the interval between the inter-cornual ridge and the apex of the nasals is the same in both; the forehead of this species is, however, one inch wider at the orbits, and is probably the largest cranium of all the fossil species.

[1] Journal Asiatic Society of Bengal, Vol. X, p. 449.

The orbit is remarkable not only for its position so much below the median line of the forehead, but for its very small diameter and nearly circular form; its longer diameter is only 2·6 inches, and the difference between the two diameters is ·2 inch. In *Bos namadicus* the longer diameter of the orbit is 3·1 inches, and the difference between the two is ·4 inch. In the much smaller cranium of *Bibos gaurus* the longer diameter of the orbit measures 2·7 inches. From the occiput being placed far beneath the overhanging frontals the temporal fossæ are shorter than in *Bos namadicus*. The ovate section of the horn-cores is undoubtedly a character of *Bibos*, but, as noticed above, some forms of *Bos namadicus* have the same form of horn-cores, and there can be no doubt as to the genus of that species.

Finally, I regard this cranium as presenting characters considerably divergent from those of the type forms of *Bos*, but not so divergent as to afford valid grounds for placing it in a distinct sub-genus, as we find approximations to those diverging characters in other species of Oxen, which undoubtedly belong to that restricted genus.

In addition to the above specimen, there are portions of two horn-cores in the Indian Museum which belong to the same species. These specimens also were collected by Mr. Theobald in the Siwaliks.

The interval between the tips of the horn-cores of this species could not have been less than nine feet, and when covered by the horn-sheaths their span must have been at least ten feet. Taking the interval between the tips of the horn-cores as nine feet, this would be equal to ten times the breadth of the cranium between the superior border of the orbits. In *Bos namadicus* the interval between the most distant parts of the horn-cores (rather below the tips) is only equal to four and a half times the width of the cranium between the orbits. In the European *Bos primigenius*, the interval between the tips of the horn-cores is slightly more than three and a half times the width of the cranium between the orbits. The large horns of *Bubalus arni*, figured in Plate 171 of the "Ossemens Fossiles," have an interval of rather less than seven feet between their tips, equal to seven and a half times the width of the skull between the orbits; the interval between the horn-cores alone would be at least a foot less than the above. Specimens of *Bubalus arni*, I am informed, have been found reaching to twelve feet between the tips of the horns, but these are very rare. As it is not improbable that other specimens of the present species were larger than this specimen, and as I have made a small estimate for the distance between the horn-tips, individuals of this species were probably quite as large as any described recent or fossil form. The circumference of the base of the horn-core is rather less than in *Bubalus palæindicus*. The present species will somewhat interfere with Cuvier's definitions of the distinctions between the form of the frontals in the genera *Bos*, *Bubalus*, and *Bison*. In the sixth volume of the "Ossemens Fossiles" (p. 220) he writes,—"*Le front du bœuf est plat et même un peu concave; celui de l'aurochs est bombé, quoi-qu'un peu moins que dans le buffle.*" The present skull is of course distinguished from those of the Aurochs by the excess

of the longitudinal over the transverse diameter of the frontals, and by the vertical position of the intercornual ridge above the occiput.

The cranium is distinguished from that of *Bos planifrons* by the form of the occiput, by the convexity of the forehead, by the horn-cores being more pyriform in cross section, and by their form and direction. In *Bos planifrons* the centre of the frontals is placed somewhat behind the anterior surface of the base of the horn-cores, whereas in the present cranium the corresponding part of the forehead, as before said, is very considerably in advance of the anterior surface of the base of the horn-cores. The differences in form between this cranium and that of *Bos namadicus* are so striking as not to require pointing out.

I do not know any existing species of oxen to which the cranium of this species shows any marked relationship; the flattened horn-cores, however, with the ridge along their superior border, have an affinity to those of the genus *Bibos*, which is confined toIndia and Burma, and also to *Bos planifrons*. It is noteworthy that almost all the Indian Oxen have flattened horns,—the Zebu, the Yák, and the typical variety of *Bos namadicus* being the only species with cylindrical horns.

The Indian Museum, besides crania, also possesses a large series of limb-bones of various species of oxen, some of which are of unusually large size, and probably belonged to the present gigantic species; it is, however, impossible to be certain in any identifications of the limb-bones of Ruminants, since those of different species and genera resemble one another so closely. The only bone which I will refer to is what I consider to be the metacarpus of this species. We have several of these large-sized ruminant metacarpals in the Indian Museum, and there is also a similar specimen mentioned by Dr. Falconer in the catalogue of the Collection of the Asiatic Society of Bengal (No. S. 346); this specimen was conjecturally referred by Dr. Falconer to a female *Sivatherium*, but it is very much smaller than the type metacarpals of that animal, and, as I shall show, is not of too large a size to have belonged to the present species.

The anterior surface of the bone is perfectly plane without any longitudinal grooving; the trochleæ of the distal extremity are bold and prominent, and there is a considerable interval between the two; the trochlear ridges are placed obliquely to one another. The shaft of the bone is much flattened and expanded laterally. Immediately above the trochleæ, the bone is perfectly flat, on the posterior surface; higher up the lateral boundaries of this surface are raised into sharp and prominent ridges. The length of the bone is equal to about three and a half times the breadth of the distal extremity.

The dimensions of the specimen as given by Dr. Falconer are as follows:—

Length of bone	13·0
Transverse diameter of both condyles	4·3
„ „ of carpal surface	4·3

The bone is considerably smaller than a specimen of the metacarpal of *Sivatherium*, described by Dr. Falconer (No. S. 345), in which the transverse

diameter of the carpal surface is 4·8 inches; the form of all the specimens is the same; and Dr. Falconer says that specimen No. S. 346 corresponds very closely with the same bone in *Bos*, differing only in its greater size.

As there are a considerable number of metacarpal and metatarsal bones in our collections, differing slightly in size one from another, it becomes a question whether they should all be referred to *Sivatherium*, or whether some of them may not really belong to *Bos*. In favour of the latter view of the case it may be stated that, with the exception of these metacarpal and metatarsal bones, the bones of *Sivatherium* are of somewhat rare occurrence, while those of *Bos* are much commoner.

If some of these bones could therefore be referred to the latter genus, it would render the proportionate number of these bones of the two genera more consonant with the number of crania. To decide this question it is necessary to find some correlation between the dimensions of the metacarpus and the cranium; such a correlation I am at present unable to discover, which will prevail in all cases, the size of any particular portion of the cranium of the *Bovina* not always increasing in the same ratio with its general dimensions.

In some cases, however, the width of the occiput does seem to be a fair criterion of size; the diameter of this surface in *Bibos gaurus* is 8·1 inches, while the transverse diameter of the condyles of the metacarpus is 2·8 inches; in *Bibos frontalis* these two diameters are respectively 7·4 and 2·4 inches. The transverse diameter of the occiput of *Bos acutifrons* is 11·4 inches, while the transverse diameter of the trochlear condyles of the present metacarpal is 4·4 inches. The proportion in all the above cases is therefore rather more than three to one; and if the metacarpus varies in size in the same proportion as the occiput, the present metacarpus would not be too large to belong to *Bos acutifrons*, under which head, as above said, I am disposed to place it. The bone is an inch wider and two inches longer than the metacarpal of *Bos namadicus*, and, if I am right in the position assigned to it, indicates that *Bos acutifrons* is the largest known species of fossil ox.

Bos platyrhinus, n. sp., *nobis*. Plate 14.

This species is founded upon the lower half of a cranium figured in the above plate. The specimen was collected by Mr. Theobald in the Siwaliks of the Kangra district, and, though less complete than might have been desired, is yet of so peculiar a form that it cannot be referred to any of the foregoing species of Siwalik oxen. Unfortunately we do not possess the lower portions of the skulls of the above-described species, so that an exact comparison between them and our present species is impossible. The only portion that is common to the skulls of the three species is the portion about the orbits; that portion, however, is amply sufficient to distinguish them from each other. The specimen is broken off across the lower border of the orbits, apparently by a very recent fracture; the portion which remains is very nearly perfect.

The cranium is at once noticeable on account of the extreme breadth and flatness of the nasal bones, which are as much as three and a half inches in width at their distal extremity; this width is three-quarters of an inch greater than the width of the nasals in *Bubalus arni,* in which the nasals are wider than in any other described Bovine, either recent or fossil. The nasals, moreover, extend very low down, reaching to within two and a half inches of the free extremity of the maxillæ; in no living species of oxen is the interval between the nasals and the maxillæ so small; the general form of the nasals is the same as in the Arni, their width at the infra-orbital angle being less than at their distal extremity.

The premaxillæ are long and extend upwards to articulate with the nasals as in *Bubalus* and typical species of *Bos*—a character which at once distinguishes the species from *Bos namadicus;* a very prominent ridge connects the apex of the nasals and the inferior angle of the orbit; the planes of the frontals and of the lachrymal are nearly at right angles to each other, being divided by this ridge. A somewhat similar ridge occurs in the crania of *Bos* and *Bibos,* although not developed to such an extent; the presence of this ridge serves to distinguish the species from *Bubalus,* to which genus the broad nasals approximate it. In the skull of the latter genus there is a deep and uninterrupted channel leading gradually down from the forehead to the sides of the face between the orbits and nasals, and no ridge or angularity. The skull is further separated from that of *Bubalus* by the free posterior edge of the palatines being entire, and unbroken by the intrusion of the vomer, as well as by the shortness of the face below the orbits.

The skull differs from all recent forms in the excessive vertical height from the crowns of the molars to the surface of the frontals; from the crown of the first molar to the anterior border of the orbit the vertical height is upwards of nine inches. In the skulls of the Gayal, the Gaur, and *Bos namadicus,* the corresponding measurement is about six inches; and in the Arni seven and a half inches. The lower borders of the orbits are not depressed below the level of the plane of the frontals, as in *Bubalus,* but are nearly continuous with this, as in *Bos namadicus.*

The skull is distinguished from the skulls of *Bibos gaurus* and *B. frontalis* by the large premaxillæ, and by the great size of the nasals.

The apex of the nasals does not reach to within half an inch of the lower border of the orbit; in *Bubalus* the nasals reach to the centre of the orbit. The palate is produced posteriorly but a short distance behind the last molars, and is undivided, as in *Bos.* The inner border of the molar series is but slightly curved: the molars have a large median accessory column on the inner side, which is but slightly constricted at its junction with the main dentine mass of the crown; the enamel of the second enamel island is deeply infolded from the posterior side, as in *Bubalus.* The measurements of this specimen are given below :—

Width at lower border of orbit	8·3
„ of nasals, at widest part	3·5
Length of „ „	7·8

Height from palate to centre of nasals	5·3
„ from posterior extremity of palate to frontals	7·8
Interval between outer surfaces of second molars	6·0
Width of palate at second molars	3 6
Length from posterior extremity of palate to muzzle	12 0
„ of six molars	6·0
Width of maxillæ at diastema	4·5

The characters by which the skull agrees with *Bos* are as follows:—

The flatness of the frontals between the orbits, and the presence of the ridge between the frontals and the nasals.

The shortness of the nasals.

The unbroken posterior border of the palate.

The low position of the apex of the nasals.

The *Bubaline* characters are—

The width of the nasals at their lower end, (being wider below than above).

The height from the palate to the frontals.

Comparing the figure of this cranium with that of *Bos namadicus*, the present specimen is distinguished from the latter by the premaxillæ reaching up to the nasals, and by the apex of the nasals not reaching to the lower border of the orbit; the nasals of the two are very different; the widest part of the nasals of *Bos namadicus* is at their infra-orbital angle, while those of *Bos platyrhinus* are far wider at their distal extremity than at this angle. The angle between the orbit and the nasals is more marked in the present species than in *Bos namadicus*, while, as noticed above, the height from the palate to the frontals is much greater in this species.

Comparing the present figure with the skull of *Bos acutifrons* on Plate 13, we find only a small portion of the cranium common to the two, *viz.*, that immediately between and below the orbits; this is, however, amply sufficient to distinguish between the two. The apex of the nasals reaches to the lower border of the orbit in *Bos acutifrons*, and the median line of these and the frontals is elevated far above the margin of the orbits, the lateral surfaces sloping away from this line; moreover, the supra-orbital sulci have their lower portion extending down between the orbit and the nasals, and there would be no prominent angle between the frontals and the lachrymals. In *Bos platyrhinus*, on the other hand, the apex of the nasals does not reach upwards to the orbit, consequently the supra-orbital sulcus lies altogether above the nasals; the frontals, between the lower angles of the orbits, are perfectly flat, the margins of the orbits being on a level with the plane of the frontals: and there is a most marked angle between the frontals and the lachrymals; and no trace of the deep and wide channel between the orbits and nasals that occurs in *Bos acutifrons*.

In *Bos planifrons*, again, the apex of the nasals reaches upwards to the middle of the orbits, which last are somewhat depressed below the level of the frontals; the median line of the frontals being very prominent. The inclination of the frontals to the basis of the cranium in this species and in *Bos acutifrons* is so sharp that the

vertical height from the palate to the frontals would have been much less than is the case in *Bos platyrhinus*, probably not much greater than in *Bibos gaurus:* a side view of those crania would, I imagine, be somewhat like that of *Bos namadicus*.

It is much to be regretted that the upper portion of this skull was not obtained, (the fracture is quite recent) that we might have been enabled to compare the characteristic upper part with those of the other species. I think the above comparisons, however, quite sufficient to establish the distinctness of the species, though I am not quite certain whether, when the occiput and horn-cores are found, we may not have to place the species under the genus *Bubalus* as an intermediate form between that genus and *Bos*. The form of the nasals is distinctly *Bubaline*, while their point of insertion and the inter-orbital region is like that of *Bos*. From the prominence of their inferior borders, the orbits probably looked almost directly outwards, as in *Bos*.

Genus: BISON.

The genus *Bison* may be defined from the characters of the cranium as follows :—

" Skull less massive than in *Bos* or *Bibos*, facial portion longer and more finely tapering; superior portion of forehead transversely arched; intercornual space centrally elevated; viewed anteriorly, this portion is a truncated cone; posterior aspect of skull triangular—more extensive than in *Bos*, but greatly less so than in *Bibos*."—*Hodgson*.

To this it may be added that the transverse diameter of the forehead of *Bison* exceeds the antero-posterior diameter; that the horn-cores are sub-cylindrical, and that their upper border is concave.

Bison Sivalensis, *Falconer*, sp. Pls. 15 and 17, fig. 1.

The single cranium, which, as stated in the introduction, I have referred to this species, is another specimen from among Mr. Theobald's numerous Siwalik collection. The greater part of the upper half of the specimen is fairly complete and perfect, although in several places the brain-case has been subjected to severe crushing. The left horn-core is broken off close to the forehead, while little more than half of the right one remains. The whole of the lower extremity of the face is broken away at a short distance below the orbits; both the temporal fossæ and the orbits are almost uninjured; it was, however, found to be impossible to completely clear the former from the hard matrix with which they are filled; the greater portion of the occipital region is complete, the hinder half of the palate, together with the last molars, have been cleared from matrix, but the occipito-sphenoidal region and the fore part of the palate is still buried in closely adhering sandstone.

On referring to the table of the frontal measurements of the skulls of the Indian Oxen, given below, it will be seen that the transverse diameter of the forehead of this specimen exceeds the antero-posterior diameter by three and a half inches—a proportion which makes the supra-nasal portion of the cranium considerably shorter than the nasal and infra-nasal portions, and gives to the upper part of the skull a great preponderance in width over the lower part.

The horn-cores are widely separated at their bases, and are placed on a ridge which is considerably below the highest point of the cranium; the superior border of this intercornual ridge is concave; when seen from in front, the summit of the superior curved line or crest of the occiput projects above and between the bases of the horn-cores, whereas in a similar view of the crania of the genera *Bos, Bibos,* and *Bubalus,* no portion of the occiput will be seen. The whole of the above characters show that the cranium belongs to the genus *Bison.*

The horn-cores are compressed antero-posteriorly; their anterior surface is flat from above downwards and concave from within outwards; their posterior surface is convex in both directions; each horn-core is marked by a longitudinal groove along the superior border; a similar groove is found in the horn-core of *Bison* (*Poephagus*) *grunniens* into which is fitted a projecting ridge on the inner surface of the horn; this ridge and groove arrangement doubtless affords additional strength to the union of the horn with the horn-core, and renders the former less liable to be knocked off by any sudden blow. The direction of the fragment of horn-core which remains attached to the skull is at first upwards, backwards, and outwards, gradually curving until its direction becomes upwards, forwards, and outwards; the whole direction of the horn-cores was probably very similar to that of the horn-cores of the living Yák, though in the fossil species the inclination forwards was probably somewhat less; the horn-cores diminish gradually and regularly in diameter; their anterior surface is concave, and their posterior surface convex.

The frontals are somewhat crushed on the left side of the cranium; they are slightly hollowed between the upper angles of the bases of the horn-cores, and below the intercornual ridge become still more hollowed out; this frontal hollow is somewhat in the form of the letter H, having one transverse portion and two lateral vertical portions as seen in the figure; the median portion of the lower half of the frontals immediately above the apex of the nasals, is prominent and swelling; a ridge, concave on its outer side, descends from the outer angle of the base of the horn-core to the superior border of the orbit. The supra-orbital foramina are widely separated and are situated on the narrowest line of the frontals; they pierce the bone at right angles to its surface; the sulci are entirely below the foramina, and are nearly vertical and of considerable depth and width as far down as the superior border of the orbit; below this point they become much shallower and converge. Between the orbit and the base of the horn-core, the cranium becomes considerably narrower from side to side, and the orbit and the base of the horn-core are separated only by a short interval. The orbit is salient, of small size,

nearly circular, and its axis looks obliquely outwards and forwards; the apex of the nasals extends upwards as far as the first third of the diameter of the orbit; the lower border of the orbit stands out very prominently and almost at right angles to the surface of the maxilla, the cranium contracting very suddenly and sharply in width beneath the orbit. Between the orbit and the nasals the bone is sharply angulated, so that the plane of the frontals and that of the lachrymo-maxillary bones are at right angles to each other; the ridge between the orbit and the nasals is obliquely grooved. The border of the orbit is slightly depressed below the plane of the frontals.

The vertical height from the palate to the frontals is but small; the temporal fossæ are remarkably short, and in consequence of the backward direction of the plane of the horn-cores very narrow; the superior rim of the orbit is an unusually broad plate of bone placed at an angle of forty-five degrees with the jugal, the latter being entirely below the orbit.

Turning now to the occipital surface, we find that the occipital crest is very prominent and of great thickness, particularly at its summit; it forms a low and wide arch with a short flattened portion at the summit; at the boundaries of the temporal fossæ this arch on either side splits into two branches to enclose the fossæ,—the upper branches join the base of the horn-cores. Between the occipital crest and the intercornual ridge, there is a depressed lozenge-shaped surface, higher in the centre than at the sides; the parietals and frontals gradually rise from the central depression to the vertex cranii; the plane of the occiput forms very nearly a right angle with that of the frontals. Below the occipital crest there is a prominent tuberosity for the attachment of the ligamentum nuchæ, and a ridge is continued downwards from this tuberosity to the superior border of the foramen magnum, which divides the surfaces for the attachment of the recti-capitis muscles. The paroccipital processes are large and recurved, and the surfaces external to them for the digastric muscles are narrow, but long. The temporal fossæ make large incisions into the surface of the occiput; these incisions are directed obliquely upwards and inwards, and their extremities are nearly on a level with the summit of the occipital crest; the summit of this crest extends nearly as high up as the median line of the bases of the horn-cores. The most elevated point of the frontals is slightly below the level of the bases of the horn-cores; there is no 'burr' at the bases of the latter. The interval between the external angles of the occipital condyles is slightly less than that between the lower border of the foramen magnum and the summit of the occipital crest, and somewhat more than half the width of the occiput at its widest part; the occipital condyles are placed very low on the occiput, and are separated by a deep fissure from the paroccipital processes.

The palate exhibits the crowns of the last three molars, which are considerably worn down, and which prove that the cranium belonged to a fully adult animal; the palate is unusually wide, and the two rows of molars run nearly parallel; the palatines are produced to the distance of about an inch behind the last molar, and their free border is not divided posteriorly by the vomer.

The crowns of the molars have wide central enamel islands, the second being infolded on the posterior side; the median accessory column on the inner side is large, with a contracted neck. The dimensions of this skull are given below:—

Width at superior border of orbits	9·5
„ at contraction above „	8·7
„ at „ below „	5·6
„ of frontals between upper angles of horn-cores	8·2
„ „ lower „ „	10·3
Greatest width of occipital crest	6·8
Interval between external angles of occipital condyles	3·9
Width of occiput between temporal fossæ	4·0
Height from lower border of foramen magnum to occipital crest	4·8
Distance between occipital crest and vertex cranii	3·4
Antero-posterior diameter of right orbit	2·2
Transverse „ „	2·2
Width of palate at 3rd molars	3·4
Interval between outer surfaces of 3rd molars	5·6
Distance from inferior border of foramen magnum to last molar	6·3
Length of last molar	1·4
„ of two molars	2·7
„ from vertex cranii to apex of nasals	5·5
„ of temporal fossæ	5·2
Circumference of base of right horn-core	10·0
Antero-posterior diameter of „	3·4
Transverse „ „	2·6
Antero-posterior diameter at fracture of ditto	3·1
Length of fragment of ditto	5·6

In the shape of the horn-cores, in their position below the highest point of the cranium, in the projection of the occipital crest between them, and in the form of the broad frontals and the salient orbits, the cranium of this species is at once seen to be widely separated from all the preceding species, and equally widely from all recent species of the genera *Bubalus*, *Bibos*, and *Bos*; the same characters also shew its agreement with the crania of the genus *Bison* and the genus or sub-genus *Poephagus*, under the former of which I have placed the species, for reasons which I will immediately shew.

Unfortunately I have been unable to obtain a perfect cranium of the Yák (*Bison* or *Poephagus grunniens*) to compare with this specimen; the Indian Museum has no specimen of the cranium of the latter genus, with the exception of one imperfect skull of a calf, wanting the occiput, and in which the characteristic points are not developed, and the frontlet of a cross-bred animal between the Yák and the Indian Ox; my comparisons, therefore, cannot be so accurate as I could have wished. A lateral and a front view of the cranium of *Poephagus grunniens* are given in Dr. Gray's Catalogue of the Ungulata of the British Museum, 1853 (*Plate 4*), together with corresponding figures of the cranium of *Bison americanus*, both on a small scale. Figures of the frontal and occipital regions of the cranium of

P. grunniens are given in Mr. Hodgson's Memoir on the Mammals of Nepal;[1] a figure of the cranium of *Bison urus* is given in Owen's "British Fossil Mammals and Birds" (p. 491).

From the table of frontal measurements given below, it will be seen that the differences between the two diameters of the forehead of this species and that of *Poephagus grunniens* are identical; but allowing for the smaller size of the present specimen, the breadth is still greater in proportion to the length than in the Yák. The orbits are rather more prominent than in the Yák; the interval between the orbits and horn-cores are nearly the same in the two species; and the form and direction of the horn-cores are also approximately similar in both species. The prominence of the orbits in the Siwalik cranium is like the orbits of *Bison americanus.* In a front view of our specimen, the summit of the occipital crest, as seen between the horn-cores, occupies only the middle two-thirds of the intercornual interval, as in the Yák, and does not occupy nearly the whole of this interval as in *Bison priscus* and *B. americanus.* The concave upper boundary of the intercornual ridge of our specimen differs from the straight boundary of the same in *Bison americanus* and *Poephagus grunniens*; the supra-orbital foramina and sulci have the same form in all the species. The frontals of the Siwalik species are slightly concave, whereas in the others they are as slightly convex. The occipital crest of the Siwalik species does not extend quite so high up on the plane of the occiput as does that of the Yák, in which the crest forms a higher and narrower arch than in this species.

Comparing the occiput of this species with that of the fossil *Bison priscus* of Europe, we find the occipital crest of the latter considerably wider and flatter at its summit, though situated at the same relative height on the occipital surface, and having the same relation to the temporal fossæ; in consequence of the greater width of the summit of this crest, the interval between the extremities of the temporal fossæ is somewhat greater than in the Indian fossil species; the slightly concave intercornual line, and the great interval between the bases of the horn-cores, is a character common to the two species. In both, the occipital crest splits at the extremity of the temporal fossa, so as to inclose the upper half of the fossa on both sides with a prominent ridge of bone. The occipital crest in both species is of great thickness, and is rounded off.

I have retained the Siwalik species in the genus *Bison,* and not placed it in the genus *Poephagus,* chiefly because the distinction between the two genera or sub-genera is founded mainly on external characteristics, of slight classificatory value, and not on important cranial differences. We have, of course, no means of knowing the external characters of the Indian fossil species, and I have therefore retained it in the original or type genus. On distributional grounds, it might perhaps be considered right to refer it to the sub-genus *Poephagus* if that genus is really sufficiently distinguished from *Bison;* the characters of the Siwalik cranium seem to be intermediate between the true *Bison* and *Poephagus.*

[1] Journal of the Asiatic Society of Bengal, Vol. X, p. 471.

The living genus *Poephagus* is now confined to the highlands of Tibet, and is seldom found much below an elevation of fifteen thousand feet. It becomes an interesting question to consider whether the allied fossil species was an inhabitant of the plains or of elevated land. I am inclined to think that it most probably was a dweller on the plains or low hills, because, with the exception of a few species of goats and sheep, all the Siwalik mammalia were plain-dwelling forms, and it is improbable that there was at any rate much elevated country within the old Siwalik area; moreover, the *Bison* of America and the *Bison* of Europe are both plain-dwelling forms. A very probable theory is that the fossil *Bison* of the Siwaliks dwelt on or near the plains, and from some cause or other in later times was induced to migrate into more and more hilly country, until finally it gave rise to the modern Yák, which cannot exist except in the rarified atmosphere of highland Tibet; at the same time the occurrence of a true Ibex, as recorded by the late Mr. Blyth,[1] in the Siwaliks, might give us grounds for taking an exactly opposite view of the case.

Genus BUBALUS.

The cranium of this genus may be defined as follows:—Horn-cores placed below the plane of the occiput, frequently triangular, forehead convex—broader than long, nasals very large and wide, occiput rounded superiorly, and with distinct indentations of the temporal fossæ; the superior border of the horn-cores concave.

Bubalus platyceros, n. sp. *nobis*. Plate 18.

It is with some diffidence that I refer the present species to the genus *Bubalus*, the cranium on which it is founded being aberrant in many points from any modern type forms. I rely, however, chiefly on the form of the occipital surface and the shape of the horn-cores, both of which are clearly *Bubaline* in the present specimen. The form of the occipital surface and its relation to the intercornual ridge appears to afford the most dependable characters in dividing the *Bovina*.

The cranium of which I have given two views is another specimen from Mr. Theobald's Siwalik collection. The greater part of the forehead and the upper half of the face are tolerably perfect; the zygomatic arches, the lower portions of the orbits, the distal half of the nasals, the premaxillæ, and the whole of the spheno-palatine regions of the skull, are wanting; the occipital region shews only the smooth supra-cristal portion, with a small part of the inferior surface for muscular attachments and the temporal fossæ; this remaining portion is, however, fortunately characteristic. The greater portion of the right horn-core remains, and a large detached fragment of the upper half of the left core was found with the specimen; this has been put into its proper position in the figure.

[1] Ann. Mag. Nat. Hist. Ser. I, Vol. XI, p. 78.

The frontals are of great size and width, particularly between the inferior angles of the horn-cores; as seen from the table of cranial measurements given on page 66, the transverse diameter of the forehead exceeds the antero-posterior diameter by rather more than one inch. The plane of the frontals is nearly flat; the median frontal suture forms a slightly elevated ridge, while a longitudinal hollow runs along its either side. The upper border of the orbit is salient, while a well-marked ridge is continued upwards from the orbit to the antero-inferior angle of the base of the horn-core. The lateral contraction of the frontals above the orbits is well marked; the latter are closely approximated to the horn-cores. Between the orbits and the nasals, the fronto-maxillary bones are concave from above downwards, and there is no trace of any ridge leading from the nasals to the orbit. The anterior border of the orbit is placed obliquely to the long axis of the cranium, so that the axis of the orbit is directed downwards as well as outwards. The supra-orbital foramina are large, and the sinuses below them are deep and converge as they descend; the foramina themselves are directed obliquely upwards, their superior border overhanging them and being produced into a conical bony projection; this overhanging projection and the direction and situation of the foramina are precisely the same as in *Bubalus;* in *Bos* and *Bibos,* on the other hand, the supra-orbital foramina are situated some distance below the upper extremities of the sulci, and are directed inwards, at right angles, to the plane of the frontals; consequently the foramina are not overhung by any bony roofs. Since the sulci do not extend above the foramina, they are necessarily very short, being only two and a quarter inches in length; they do not extend below the orbits; the supra-orbital sulci of *Bubalus arni* are of precisely the same form and length as those of the present specimen, and agree very closely.

The nasals extend very high up on the forehead, reaching to a point above the level of the centre of the orbits; at their apex the nasals form an acute angle, and they are wider at their infra-orbital angle than at any other point, diminishing in width rapidly below this angle. The frontals are rounded off superiorly, to join the occipital surface, so that the plane of the supra-cristal portion of the occiput forms an obtuse angle with the plane of the forehead. From the great width of the forehead, and its comparative shortness, and from the upward extension of the nasals, it is probable that the length of the facial portion of the skull exceeded that of the frontal. The lower portion of the nasals is much arched and vaulted, the lateral surfaces of the maxillæ sloping outwards rapidly from the median line.

The temporal fossæ are long and narrow; their inner walls do not slope inwardly posteriorly; what remains of the posterior border of the orbit, shows it to have been unusually wide and strong.

The occipital surface is divided by the large occipital crest or superior curved line into two semi-distinct portions; the smooth supra-cristal portion, and the rough infra-cristal portion for muscular attachments; the supra-cristal portion of the

occiput is not continued upwards in the plane of the infra-cristal portion, but slopes forwards to join the frontals by a gentle curve, so that there is no well-marked and angular intercornual ridge overhanging the occiput; between the superior angles of the horn-cores, the surface of the frontals is concave from side to side.

The occipital crest or curved line itself forms a very wide and flattened arch; the extremities of the indentations of the temporal fossæ are situated entirely above the summit of this arch; and the horn-cores, again, are above these, so that there is a considerable vacant space between the true occipital surface and the horn-cores; the temporal fossæ cut deeply into the occiput on either side, so that the width of the parietals between them is probably not greater than the interval between the external angles of the occipital condyles. The proper muscular surface of the occiput is deeply marked by ridges and grooves; a circular depression occurs immediately above the summit of the crest; at the highest point of the frontals the outline of the intercornual ridge is convex.

The horn-cores are triangular in cross-section and are set obliquely on the frontals; their superior angle is somewhat below or in advance of the plane of the true occipital surface, so that they are not situated on the highest portion of the cranium. The cross-section of the base of the horn-cores has the form of an isosceles triangle, the inferior surface forming the base of the triangle; the plane of the anterior surface is continuous with the plane of the frontals; their antero-inferior angle is round and blunted, while their superior angle is remarkably sharp, and looks directly upwards. Their inferior surface is situated nearly at right angles to the plane of the frontals; their postero-inferior angle is the most obtuse of the three. The horn-cores diminish somewhat rapidly in diameter, and are directed outwards, upwards, and somewhat forwards, forming one regular curve, the upper border being concave, and the lower convex throughout their length; at a distance of nine inches from the median line of the skull, the anterior surface of the horn-core is placed one and a half inches in advance of the plane of the frontals; there is a small "burr" at the junction of the horn-cores with the frontals.

From the imperfection of the lower portion of the face it is impossible to determine the relations of the premaxillæ to the other bones.

The measurements of this specimen are given below in inches:—

Width of cranium at superior border of orbits	9·3
„ at constriction above orbits	8·4
Interval between occipital crest and superior angle of horn-cores	3·2
Length from superior angles of horn-cores to apex of nasals	8·0
Width of parietals between temporal fossæ	5·0
Interval between superior angles of bases of horn-cores	4·0
„ „ antero-inferior angles of ditto	9·0
„ „ orbit and base of horn-core	2·4
Antero-posterior diameter of right orbit	2·9
Interval between supra-occipital foramina	4·5
Length of temporal fossa	7·0
Width of nasals at widest part	2·6

Width of anterior surface of base of right horn-core	6·1
„ inferior „ „	3·3
„ posterior „ „	5·5
Circumference of base of horn-core	16·5
Length along convexity of right horn-core (broken)	15·0
„ concavity „ „ „	12·0
Longest diameter of broken tip of ditto	2·7

The dimensions of a detached and broken horn-core of this species collected by Major Godwin-Austen in the Siwaliks, near the Markanda River, are as follows:

	Inches.
Greatest diameter of base	5·9
Length along inferior convex border	22·0
„ „ superior concave border	17·0
Greatest diameter at broken tip	2·7

The form of this horn-core is the same as those of the specimen described above, though it is of rather larger dimensions.

In the collection of the Asiatic Society of Bengal, there is a cast of a cranium of this species, from the Siwaliks, the original of which is, I presume, in the British Museum; the horn-cores of that specimen are rather longer than in the described cranium, but not much larger than the detached specimen collected by Major Godwin-Austen.

The cranium is distinguished from the crania of the genus *Bos* by the following characters:—

The direction and triangular cross section of the horn-cores.

The rounding off of the fronto-parietal region between the horn-cores.

The occipital crest being placed below both the indentations of the temporal fossæ and the lower border of the horn-cores.

The short interval between the horn-core and the orbit, and the saliency of the latter.

The excess of the transverse over the antero-posterior diameter of the forehead of the cranium.

The upward extension of the apex of the nasals.

The excess of length of the facial over the frontal portion of the skull.

The obliquity of the anterior border of the orbit and the concavity between this and the nasals.

The position and direction of the supra-orbital foramina and sulci.

In all the characters in which this cranium differs from *Bos* it approaches to *Bubalus*.

The nasals differ from those of *Bubalus arni* and *Bubalus caffer*, by being wider at their infra-orbital angle than at any other part, but this is a character which is found in the nasals of *Bubalus palæindicus*, as will be noticed below.

The cranium differs from that of *Bubalus arni* in that the horn-cores are placed much closer together on the frontals; they, however, occupy a similar position in the cranium of *Bubalus caffer*. If the cranium of *Bubalus arni* be placed

horizontally, the centre of the frontals will be the highest point of the whole; the plane of the face, that of the parietals, and the planes of the anterior surfaces of the horn-cores, sloping away on all four sides from this central point. In the cranium of the present species, however, only the planes of the frontals and of the parietals slope away in this manner; the horn-cores, instead of being directed upwards and backwards, as in the Arni, are directed upwards and forwards, so that their bases are in advance of the central frontal plane; this position of the horn-cores prevents the present species from having the rounded and prominent forehead, characteristic of *Bubalus arni.* The frontals of *Bubalus caffer*, however, in the young state, are somewhat concave between the bases of the enormous horn-cores; while in *Bubalus brachyceros* the whole of the frontals are flat, and the horn-cores somewhat approximated at the vertex crania. The convexity of the frontals cannot therefore be taken as a valid generic character, as is done by Mr. Hodgson in his above-quoted paper on the genera of Indian cattle.

The present cranium is distinguished from those of all species of the genus *Bibos* by the direction and triangular cross-section of the horn-cores, as well as by the rounded fronto-parietal surface, and by the shape and position of the nasals and supra-orbital foramina. The concavity of the horn-cores is, however, similarly placed upwards in both genera. In the present species there is no approach either to the long and straight intercornual ridge of *Bibos frontalis,* placed immediately above the true occipital surface, or to the highly arcuated intercornual ridge of *Bibos gaurus.*

On comparing the figure of the occiput of the present species with Mr. Hodgson's figure of that of *Bibos frontalis,* it will be seen that the occipital crest of the latter extends higher up on the occiput than in the former; consequently in *Bibos* the inner extremities of the temporal fossæ are not placed entirely above the occipital crest, whereas they are so placed in the present species, in which the interval between the fossæ is greater. In both there is a large shield-shaped protuberance for the nuchal ligament, and wide smooth surfaces for the recti muscles. The summit of the occipital crest forms a very high arch in *Bibos,* whereas it is nearly flat in the present species; the supra-cristal portions of the two are so different as not to require a detailed comparison.

Turning again to the occiput of *Bubalus arni* and comparing it with the present specimen, we find that in both species the inner extremities of the temporal fossæ are entirely above the occipital crest; and the interval between the fossæ has the same length in the two; the crest is, however, flatter and placed lower down in the fossil species. The supra-cristal portion in both slopes forwards, though in the one it is extremely wide and in the other narrow, the width of the cranium of *Bubalus arni* being greater than the interval between the temporal fossæ, whereas in *Bubalus platyceros* the reverse is the case. The point of attachment of the ligamentum nuchæ in the former species is continued downwards as a bony septum between the surfaces for the attachment of the recti muscles. There is a somewhat similar flattened depression above the summit of the occipital crest in both, which is not found in other

forms. If the line of the occipital crest in the present specimen were perfect, the interval between this and the lower border of the base of the horn-cores would be far greater than in any other species. The intercornual portion of the occiput is depressed between the bases of the horn-cores in *Bubalus platyceros*, and raised above them in *Bubalus arni.*

The greater separation of the plane of the true occiput from the plane of the parietals and the post-cornual portion of the frontals in this species than in *B. arni*, is an approach to the Antelopine form of skull, and a wide departure from the high intercornual crest of *Bos.*

The above comparisons show that this cranium has most points of resemblance to the crania of the genus *Bubalus*, and we are therefore justified in classing it with that genus; the characteristic points of the cranium have been already noticed in the Records of the Geological Survey of India.[1]

Bubalus palæindicus, *Falconer*. Pl. 17, f. 2, and Pl. 19.

Of this magnificent species of fossil buffalo no complete description of the cranium has ever appeared, though short notices of it will be found in Dr. Falconer's Catalogue of the Vertebrate Fossils in the collection of the Asiatic Society of Bengal, and a figure and notes are given by Dr. Spilsbury in the Journal of the Asiatic Society of Bengal.[2] A figure of a very complete, though partially restored, cranium with the horn-cores attached will be found in Plate XXII of the "Palæontological Memoirs;" this figure is copied from Plate G of the unpublished plates of the "Fauna Antiqua Sivalensis," where other imperfect crania are also figured.

The Indian Museum possesses a cranium of this species, of which two views are given in the accompanying plates (XVII, fig. 2, and XIX), and which exceeds in size any other specimen which I have seen. The specimen is from the Nerbudda valley, and were it not for the loss of the greater part of the horn-cores it would be in a splendid state of preservation.

The greater part of the right horn-core and almost the whole of the left horn-core are absent from the specimen figured; the distal portion of the nasal bones, with a small part of the extremity of the maxillæ and the whole of the premaxillæ are also wanting; the right pterygoid and the pterygoid process of the same side have also been broken away. The crowns of the whole of the premolar series are broken off even with their alveoli; the two last molars of the right side and the whole three of the left side are, however, quite complete. The bone is firm, although it adheres strongly to the tongue; with the exception of the fronto-nasal sutures all the cranial sutures are completely obliterated; the molars are also well worn, so that the skull belonged to a fully adult individual, which was in all probability a male.

[1] Vol. X, p. 131.

[2] Vols. III, VIII, IX, X, and XIII.

The cranium is immensely larger and more massive in all its proportions than that of the largest male Arni I could obtain for comparison. All the ridges and hollows for muscular attachment are much more prominent, indicating an animal of immense strength and power. Size alone, however, would afford no ground for specific distinction; since, as is well known to sportsmen, the recent buffaloes of Assam are diminishing steadily in the size of their skulls and horns under the constant persecution to which they are subject; in early times they were probably of much larger size than any specimens now existing.

As the resemblance between the crania of the living and fossil Indian buffaloes is so close, it will be best to commence by comparing the two together; on the frontal aspect the cranium of *Bubalus palæindicus* is considerably broader in proportion to its length, and the infra-orbital region is less contracted laterally; the frontals are more elevated between the inferior angles of the horn-cores, in consequence of which there is a sharp descent from this part of the forehead to the orbits, in place of the regular and even slope which we find in the forehead of the Arni.

In the figured specimen the superior border of the orbit is shorter and thicker and stands out more abruptly from the lateral surface of the frontal than in the Arni; the anterior border of the orbit is produced laterally almost to the same extent as the posterior border, in consequence of which in the frontal aspect of the cranium only a very narrow segment of the orbit comes into view; the axis of the orbit being directed almost immediately outwards. In the cranium of *Bubalus arni*, on the other hand, the anterior border of the orbit is much less produced than the posterior border, and consequently the greater portion of the orbit is visible from the front; the axis being directed outwards and forwards. In Dr. Falconer's restored figure of the cranium of *Bubalus palæindicus*, however, the orbits are drawn of the same shape and direction as those of *Bubalus arni*, and the direction of the anterior border of the orbit in the Arni occasionally varies in different individuals; so that the above cannot be taken as a constant character.

Between the orbit and the supra-orbital foramen there is a very prominent ridge of bone, forming the external border of the supra-orbital sulcus, this external border being much higher than the internal border; in the figured specimen there is no supra-orbital foramen on the right side, although the sulcus is present. The anterior border of the orbit is entire, and not notched as in the Arni. Above the orbit the cranium has a much greater depth than occurs in the cranium of the Arni; this is probably due to the greater development of the frontal sinuses. The interval between the lower border of the frontal, overhanging the temporal fossa, and the vertex cranii, is 4·9 inches, while in the Arni it is only 3·6 inches.

In a profile view of the two crania, that of the Arni is seen to slope rapidly and continuously away from the vertex cranii to the extremity of the nasals, so that the anterior surface of the nasals, at a distance of two inches below the orbit, is situated one and a half inches below the plane of the superior border of the orbit. (The crania

are supposed to be placed on a horizontal surface, resting on the paroccipital processes and anterior molars.) On the other hand, in the cranium of *Bubalus palæindicus* there is a very abrupt and sharp slope downwards from the vertex as far as the orbits; and then the nasals are continued downwards with a less steep slope, so that at a corresponding distance below the orbits, the anterior surface of the nasals is in the same plane with the superior border of the orbit: this difference may, however, be brought about by a greater or lesser development of the frontal sinuses.

Below the orbits there is a considerable difference in the form of the two crania; in *B. palæindicus* there is less lateral contraction of the maxilla below the orbit, and the external surface of this bone slopes much more rapidly towards the median line than in the recent species; this is caused by the very different form of the nasals in the two species; in *Bubalus arni* these bones are very broad and flattened, with no great width at their infra-orbital angles, and becoming wider towards their distal extremities; the infra-orbital angle is placed considerably below the inferior border of the orbit: from the wide and slightly-arched form of the nasals the transverse section of the nasal cavity presents a low and wide arch, broader than it is high; the transverse diameter of the nasals at their infra-orbital angle is one and a half inches, and at a point three inches below the orbit, two and a half inches. In *Bubalus palæindicus* the nasals are much wider at their infra-orbital angle than at any other point, and become rapidly narrower below this point; the specimen does not, however, show their distal extremity; instead of being nearly flat in the middle of their course, they are greatly rounded and arched, so that the lateral surfaces become very nearly at right angles to the plane of the median surface; the infra-orbital angles reach almost as high as the inferior border of the orbits: the transverse diameter of these bones at the infra-orbital angle is two and a half inches, and at a distance of three inches below the orbit two inches,—the latter diameter being considerably less than the corresponding one of the smaller-sized cranium of the Arni. The nasal cavity in transverse section forms a vaulted arch, higher than broad, its boundaries forming an isosceles triangle, whereas the corresponding boundaries of this part of the Arni's cranium approximate very closely to an equilateral triangle.

The length of the two crania from the inferior border of the foramen magnum to the anterior extremity of the true molar series is also considerably different, being upwards of three inches longer in the fossil than in the recent species; this is correlated by the enormous width of the occipital region of the former, exceeding that of the latter by two and a half inches.

The spheno-palatine region of the cranium of *Bubalus palæindicus* is at once distinguished from that of the Arni by the relative directions of the bones composing the basi-cranial axis and the surface of the palate: in the cranium of the former species, a straight rod resting on the palatal surface will also rest on the whole of the basi-sphenoid and basi-occipital; whereas in the latter species a similarly placed rod would only touch the basi-occipital close to the foramen

magnum. In the cranium of the adult Arni this obliquity of the sphenoid to the plane of the palate is less than in young individuals, but in no specimen that I have seen is there any approach to the identity of the planes of the two surfaces, seen in all the specimens of the cranium of *Bubalus palæindicus* which have come under my observation.

Again, if a transverse line be drawn across the frontals through the centres of the orbits of the two crania, the space between this and the intercornual ridge will form an almost exact square in *Bubalus palæindicus;* while in *Bubalus arni* the antero-posterior diameter of a similar space will be one and a half inches longer than the transverse diameter; this difference being partly due to the different forms of the anterior borders of the orbits described above.

In *Bubalus palæindicus* the surface of the palate is produced backwards behind the last molar to nearly double the distance that it is in *Bubalus arni;* in the former the length of the palate behind the last molar is 2·6 inches, and in the latter only 1·3 inches; the posterior nares are consequently placed much further back in the fossil species. In both species the free edge of the palatines is mesially bisected by the vomer.

The maxillo-palatine suture can just be distinguished in the figured specimen, and is placed entirely behind the posterior palatine foramina; whereas in the recent species the suture bisects these foramina; in both species the suture commences at the interval between the penultimate and ultimate molars, and at the median line is on a level with the interval between the antepenultimate and penultimate molars.

The pterygoid processes of the alisphenoid are much larger and stouter in the fossil species, and extend lower down below the plane of the molar alveoli: the surface of the palate itself is also more arched from side to side.

The horn-cores are placed on the frontals similarly in both species; they are of larger size and directed more outwards in the fossil species; specimens of the recent species from Assam and Cachar most nearly resemble the fossil form in this particular.

On comparing the occipital surfaces of the two crania, we find more differences than in the frontal aspects; the occipital surface of *Bubalus palæindicus* forms a very wide and flattened arch, with the crest distinctly and clearly marked, and its lateral borders convex; this convexity causes the temporal fossæ (perfect on the right side of the figure) to become very low and narrow; on the occipital surface the indentations of the fossæ appear as pointed triangular slits on either side of the crest; the protuberance for the nuchal ligament is slight, and is not continued downwards as a sharp ridge to the foramen magnum; this narrowness of the temporal fossæ, Dr. Falconer says, is constant in all the specimens examined by him. The occipital crest of *Bubalus arni* forms a higher and more irregular arch, being flattened at the summit, and less prominently and sharply defined; its lateral boundaries are somewhat concave, and the temporal fossæ are consequently of considerable width throughout their length, and terminate superiorly in a blunt rounded

extremity; the tuberosity for the nuchal ligament is strongly marked, and superiorly confluent with the supra-cristal portion of the occipital surface; inferiorly it is produced into a strong vertical ridge, affording attachment to the septum between the occipital muscles. The occipital condyles are less obliquely placed, and their external angles somewhat less sharp in the recent than in the fossil species.

The basi-occipital of *B. palæindicus* is distinguished from that of *B. arni* by its much greater relative width: 4·1 inches in place of 2·9 inches across the posterior muscular tuberosities; these tuberosities are also nearly double the size of those of the Arni.

The pattern of the crown of the molars of the two species is very similar, though the teeth can be distinguished. The enamel islands in the fossil species are unusually large, and their free surface much corrugated and rugose: on the internal side the median accesory tubercle is of very large size. The ultimate molar is nearly half an inch longer than the corresponding tooth of the Arni: this extension in length is chiefly caused by the great development of the postero-external angle, which almost forms a separate third lobe, being divided from the main body of the tooth by an infolding of enamel from either side; the infold of enamel on the posterior side of the second enamel island, in all the molars, is much deeper in the fossil species, and consequently remains on the worn crown for a much longer period than in the recent species. Below, the measurements of the figured specimen are compared with those of a cranium of an adult male Arni:—

	B. palæindicus.	*B. arni.*
Interval between foramen magnum and occipital crest	4·2	3·7
„ „ occipital crest and vertex cranii	4·5	4·4
Width at superior border of orbits	11·6	10·0
„ at constriction above orbits	11·0	9·4
„ „ below „	8·4	6·5
From occipital crest to tip of nasals (*B. palæindicus*, broken)	20·0	21·0
Width of occipital through petrosals	10·0	8·5
Height from surface of palate to frontals	7·8	6·6
Length from foramen magnum to last premolar	14·5	11·8
Interval between external angles of occipital condyles	6·2	5·1
„ „ occipital crest and base of horn-core	2·9	2·2
Length of temporal fossa	7·5	7·0
„ of intercornual ridge	7·3	6·0
Height from palate to broken extremity of nasals	6·0	5·0
Interval between base of horn-core and orbit	2·5	2·4
Antero-posterior diameter of left orbit	3·0	2·8
Transverse „ „	2·6	2·5
Length of five molars	6·3	5·8
Width of palate at second molars	4·1	4·0
Interval between outer surfaces of ditto	6·4	5·9
„ „ supra-orbital foramina	6·5	5·3
„ „ occipital crest and line connecting mid-orbits	12·0	10·0
Length of outer surface of second molar	1·6	1·3
Transverse diameter of „	1·2	1·0
Length of outer surface of ultimate molar	1·8	1·4
Interval between extremities of paroccipital processes	6·1	5·0

	B. palæindicus.	*B. arni.*
Interval between outer surfaces of zygomatic arches	11·0	10·0
Length from foramen magnum to free extremity of palatines	7·6	6·9
Antero-posterior diameter of right horn-core at base	7·3	5·2
Transverse ,, ,, ,,	2·8	2·5
Circumference of ,, ,,	18·6	13·0
Width of occiput between temporal fossæ	7·0	5·1

Another specimen of the cranium of *Bubalus palæindicus* in the Indian Museum, also from the Nerbudda valley, and consisting of the upper part of the cranium and the bases of the horn-cores only, has the following dimensions :—

	Inches.
Width at constriction above orbits	9·5
,, of occipitals through petrosals	11·0
Interval between external angles of occipital condyles	5·1
From occipital crest to vertex cranii	4·2
Width of occipital between temporal fossæ	6·2
Interval between foramen magnum and occipital crest	4·3
,, ,, supra-orbital foramina	5·4
,, ,, inferior angles of horn-cores	11·0
Antero-posterior diameter of base of left horn-core	6·4

The frontals of this specimen are remarkable for their extreme convexity between the bases of the horn-cores, and from their rough and corrugated surface : the form of the occiput agrees in every detail with that of the last specimen. I may here add a few notes and measurements of the crania of this species taken from Dr. Falconer's Catalogue of the Fossil Vertebrata in the collection of the Asiatic Society of Bengal. The finest specimen of the cranium of this species, marked No. N. 18, was obtained from near Sagouni in the Nerbudda valley; its dimensions are as follows :—

	Inches.
Length of right horn-core	33·0
Breadth of ,, at base	6·5
Thickness ,, ,,	4·5
Length of left horn-core (broken)	23·0
Breadth of skull at base of occiput	13·0
Height from condyles to plane of frontals	10·0

" The horn-cores spread out more horizontally and with a less inclination upwards than in the existing wild buffalo, slightly concave anteriorly, and convex behind. A cord stretched between the tips would subtend the plane of the cranium behind the frontals ; in all these respects differing from the existing wild buffalo, and, so far as their horizontal offset is concerned, approximating to the Gayal, from which, however, they differ in the flattened form of the horns and in every other respect. The posterior border of the horn-cores encroaches much upon the temporal fossa, which is narrow. These characters are so constant, as shown by still better specimens in the British Museum, that there can be little doubt but that the species is distinct from the existing wild buffalo."

It will be observed from the above that the narrowness of the temporal fossa is characteristic of Dr. Falconer's specimen as of our figured specimen; the outward direction of the horn-cores does not, however, appear to be of much value, as the female of the Assam variety of the existing species possesses nearly horizontally directed horns, as in the fossil species.

A specimen (No. N. 20), which Dr. Falconer regarded as probably belonging to a female individual of this species, has the following dimensions:—

	Inches.
Length	17 50
Height from sphenoid to frontal	8·00
Width at constriction between orbit and horn-core	8·25
„ between middle of orbits	7·50
Length from vertex to upper margin of orbit	7·50
„ of line of molars	6·50
Greatest width of left horn-core	5·00
Thickness of „	3·00

A large detached horn-core of a male individual (No. N 32) has the following dimensions:—

	Inches.
Length of fragment	11·0
Girth near base	19·7
Long diameter	7·0
Short „	4·5

From the above comparisons and measurements we find that the cranium of the fossil Indian buffalo differs in the following points from the cranium of the existing wild buffalo, *viz.*, in its larger size, in the form of the infra-cristal portion of the occipital surface, and in the narrowness of the temporal fossæ; in the form of the orbits, nasals, and nasal cavity, and in that of the ultimate molar; in the degree of the inclination of the basi-cranial axis to the plane of the palate, and in the backward prolongation of the palatines; the most important of these differences appear to me to be those relating to the nasals, the temporal fossæ, and the basi-cranial axis and palate. The whole of the differences are but slight, and yet they are quite sufficient to distinguish the skull of the fossil from that of the recent form, and I therefore think it best to continue to consider the two forms as distinct species in the modified acceptation of the term, although there can be no doubt but that the one species is the direct ancestor of the other. In opposition to this view, however, I see that Mr. Boyd-Dawkins[1] considers the fossil form (misnamed in his notice *Bubalus namadicus*) as specifically identical with the living *Bubalus arni;* this determination was apparently made on the evidence of Dr. Falconer's comparison of the two crania.

The fossil species ranged throughout a great portion of the central Nerbudda valley, and its remains have been noticed by Dr. Falconer from the older alluvium of the Jamna valley; bones of this species have also been obtained by Mr. Fedden

[1] Cave Hunting, p. 428.

from the older alluvia of the Godavari and Perim-Ganga valleys, and I think by Mr. Foote from Madras; all the above deposits undoubtedly belong to the upper Pliocene or Pleistocene periods. Lately, however, as I have already previously noticed,[1] two crania of this species have been obtained by Mr. Theobald from the topmost clay beds of the Siwaliks near the town of Bubhor; these crania were found in company with the remains of *Camelus sivalensis,* and the beds are certainly newer than those from which the great mass of Siwalik bones are obtained; I have thought it very probable from the occurrence of this *Bubalus* in these beds, and not in the beds below, that these beds are not far removed in time from the ossiferous gravels of the Nerbudda valley. Mr. Medlicott, however,[2] on stratigraphical considerations, is inclined to think that there is a long gap between these topmost Siwaliks and the Nerbudda deposits; the old high level terraces of the Sub-Himalayas being more nearly contemporaneous with the latter deposits, and there is no doubt considerable probability in this supposition. It is, however, very unlikely that a species like *Bubalus palæindicus* (for, as we shall see below, except in the matter of size, I cannot distinguish between the upper Siwalik and Nerbudda crania) which has been considered by some as identical with a living species, should have existed at a period much older than that of the gravels of the Nerbudda. There is no doubt, however, but that the Bubhor Siwaliks are serially continuous with, and are not separated by, any (geologically) long period from the subjacent mammaliferous beds, and the occurrence of *Bubalus palæindicus* in the former is another link in the chain of arguments for not placing the age of the great mammaliferous series of the Siwaliks below the older Pliocene.

To return to the Siwalik crania, we find that both of them are of considerably smaller size than the average of the specimens from the Nerbudda valley; the larger of the two is, however, certainly an adolescent animal, the crowns of the last molars having only just come into wear, and most of the cranial sutures being still distinctly visible; the skull is slightly larger in its dimensions than the female skull from the Nerbudda noticed above, and it is therefore probable that both the Siwalik specimens belonged to female individuals.

The extremity of the larger skull has been broken off between the premolar and molar series, both zygomatic arches are wanting, together with considerable portions of the boundaries of the orbits; part of the right frontal with its horn-core, and the greater part of the left horn-core, are also wanting; the sphenoid region is considerably injured, both the paroccipital and one of the pterygoid processes having been broken off; in the right maxilla there are crowns of three molars remaining, a portion of their outer walls being, however, broken away; on the left side there are only portions of the fractured crowns of the two ultimate molars.

[1] Rec. Geol. Surv. India, Vol. IX, p. 88.

[2] Rec. Geol. Surv. India, Vol. IX, p. 57.

This specimen agrees with the Nerbudda crania in having narrow and arched nasals, with the highly vaulted nasal cavity; the anterior border of the orbit, though fractured in our specimens, seems also to have been produced in a similar manner; the occipital surface agrees precisely in form with the Nerbudda specimens. The proximal extremity of the nasals extends upwards on the face as far as the centre of the orbits: the fronto-nasal suture is distinct, and terminates in a simple unbroken angle, there being no process of the frontals descending between the two apices of the nasals as in the Arni; the palate is produced still further back than in the Nerbudda specimens, and therefore differs still more widely from that of the Arni: the portion of the horn-core which remains is directed outwards as in the Nerbudda specimens. The dimensions of the specimen are as follows :—

	Inches.
Interval between occipital crest and foramen magnum	3·4
„ „ and vertex	4·4
Width at constriction above orbits	9·2
„ below „	7·6
Length from occipital crest to tip of nasals (broken)	17·0
Width of occiput through petrosals	8·8
Height from palate to frontals	6·2
Interval between foramen magnum and last premolar	13·0
„ „ external angles of condyles	5·3
Length of intercornual ridge	6·0
Interval between orbit and horn-core	1·8
Antero-posterior diameter of orbit	2·4
Length of three molars	4·2
Width of palate at second molars	3·4
Interval between outer surfaces of second molars	5·8
„ „ supra-orbital foramina	3·6
Width of occiput between horn-cores	4·4
Antero-posterior diameter of base of horn-core	6·4
Transverse „ „ „	3·0

The second Siwalik specimen, though of somewhat smaller size, agrees in form with the described specimen.

I have elsewhere stated[1] that another species of buffalo, *Bubalus antiquus*, has been described by Professor Gervais[2] from newer Tertiary strata in Algeria, which in the form of its occiput, of its horn-cores, and of its frontals, approaches much more closely to the Indian than to any of the African buffaloes; it has, however, certain points of affinity to the African *B. brachyceros;* the existence of this species is important, as showing a former intermingling of the Mammalian Tertiary Faunas of India and Africa.

In the valleys of the Godavari and Nerbudda, *Bubalus palæindicus* was undoubtedly a contemporary of man, since stone implements have been found in the ossiferous beds of localities from which the remains of the extinct buffalo are obtained.

[1] Rec. Geol. Surv. India, Vol. IX, p. 99. [2] Zoologie et Paléontologie Generales: prem. ser. pl. XIX.

Genus: PERIBOS, n. gen. *nobis*.

The name of this new genus, or, perhaps, sub-genus, inadvertently appeared without any descriptive notice in my paper on Indian Tertiary Mammalia published in the "Records of the Geological Survey of India."[1]

The genus is founded upon the single cranium described below, and from cranial characters, may be defined as follows:—Frontals flat, and broader than long; horn-cores pyriform in cross section, short and curved, closely approximated at their bases, and situated on a ridge of the frontals, which is somewhat below the plane of the occiput; the true occipital surface bounded by its crest, and the latter approximated to the horn-cores; teeth and basi-occipital of the Bovine type.

Peribos occipitalis, *Falc.* sp. (?). Pls. 20 and 21, f. 2.

The doubt as to the original application of the above specific name to the figured cranium has been already noticed in the introduction, and need not be repeated here. The specimen is in the Siwalik collection of the Asiatic Society of Bengal; it is numbered in the Catalogue of the Society's collection S 562, and has been there described by Dr. Falconer; it was obtained from the Siwaliks of Ganawur, and has been referred to in the "Journal of the Asiatic Society of Bengal."[2] Dr. Falconer's description of the specimen is as follows:—

"Fine skull of a *Bovine Ruminant*, nearly perfect from the occiput to the diastema, showing the zygomatic arches, temporal fossæ, and the whole of the spheno-palatine region, together with two lines of molars *in situ;* the crowns of those on the right side broken off; the three posterior molars on the left side nearly entire; a horn-core is present on the left side, absent on the right, through a fracture which has carried it off below the base. The cranial part of the skull differs remarkably from all known *Bovine Ruminants* in this respect, that the occipital bone appears to terminate at the occipital crest, or close to it, and that no part of the parietals enters into the occipital plane.

"The horns are pyriform in section, with a very sharp edge behind, and a broad surface in front; they are closely approximated on the brow, and start upwards and outwards, but curve forwards towards their tip. The plane of the frontals is flat between the commencement of the horns, and then descends in a sudden curve between the horn-cores to meet the plane of the occipital at an obtuse angle. The occipital crest is very prominent; orbital rim also prominent; the lachrymal bones present rough tuberosities at the orbital margins, as in the *Bovine* group; there is also no lachrymal fissure; the two supra-orbital foramina large.

[1] Vol. IX, p. 90.

[2] Vol. V, p. 184.

The nasals are received into an angular fissure of the frontals, their apices ascending nearly to a line with the anterior (inferior) border of the orbits.

"The orbits differ in a remarkable manner from those of the ordinary *Bovine Ruminants* in having their greatest diameter in the vertical direction instead of antero-posteriorly. Between the supra-orbital foramina there is a raised portion of the surface of the frontals of a horse-shoe shape, about a line in thickness, and with a rugous and fimbriated margin about two inches in breadth; the sinus at the posterior (superior) part passing gradually into the surface of the frontals. This rugous disc is unknown in other Ruminants. The maxillaries contract sharply in front of the orbits; their tuberosities are very prominent.

"*Teeth.*—The three posterior molars on the left side are well worn, showing the animal to have been fully adult, and a large accessory pillar, narrow and compressed, but of considerable depth, is seen in the sinus between the two barrels of each molar on its inner side as in the *Bovine Ruminants.* The palate is broad."

Most of the following dimensions were also given by Dr. Falconer :—

	Inches.
Length from occipital condyles to diastema	12·6
,, summit of occipital crest to apex of nasals	8·6
Width at superior border of orbits	7·7
,, at constriction below ,,	5·5
,, at inferior border of ,,	6·0
,, at constriction above ,,	6·9
From base of occipital to summit of occipital crest	5·1
Width of occipital through petrosals	8·5
Height from surface of palate to frontals	7·0
Interval between external angles of condyles	3·8
Distance between occipital crest and base of horn-core	1·1
Length of temporal fossa	5·5
Interval between bases of horn-cores	2·0
Height from palate to broken extremity of nasals	4·5
Interval between base of horn-core and orbit	1·9
Transverse diameter of left orbit	2·7
Antero-posterior diameter of left orbit	1·9
Transverse diameter of right orbit	3·0
Antero-posterior diameter of right orbit	2·0
Length of five right molars	4·9
Greatest width of palate	3·3
Length of fragment of left horn-core	9·0
Antero-posterior diameter at base	5·0
Thickness of ditto	3·0
Antero-posterior diameter at fracture	3·4
Transverse ,, ,,	2·7
Height from surface of palate to frontals below orbit	6·0
Interval between supra-orbital foramina	4·7
Distance between outer surface of first molars	5·1
Width of nasals at infra-orbital angle	2·6
Interval between temporal fossæ above horn-cores	2·9

"The dimensions of the two orbits differ a little in consequence of crushing on the right side. The principal distinctive marks are: The occipital not rising

above the occipital crest. The great narrowness of the parietal region between the horn-cores and the occipital crest. The close approximation of the horn-cores. The short interval between the horn-core and the orbit. The projection of the orbit above the plane of the frontals."

To the above description I add the following remarks: On referring to the table of the frontal measurements on the crania of Indian oxen given below, the transverse diameter of the forehead of this specimen will be found to be considerably longer than the antero-posterior diameter. The nasals are very highly arched, and are widest at their infra-orbital angle, diminishing very rapidly in width below this point; there is a ridge between the infra-orbital angle of the nasals and the orbit. The supra-orbital foramina pierce the bone obliquely, and are placed at the extremities of the sulci; the sulci do not extend downwards as far as the lower border of the orbit; the orbits have their posterior border prominent at the inferior angle, their axis looks obliquely forwards and outwards. The constriction of the skull above the orbits is of no great extent.

As noticed above by Dr. Falconer, no portion of the parietals of this cranium enters into the plane of the occipital surface; that surface is consequently bounded superiorly by the occipital crest, and is composed solely of the proper occipital bones which do not extend above the crest. The parietals are in a different plane from the occiput, sloping upwards to the highest ridge of the cranium, which is in consequence placed considerably in advance of the plane of the occipital, instead of being directly over it, as in *Bos;* this form of the hinder part of the cranium is an approach to the still more aberrant form of the cranium of the next genus *Hemibos;* owing to the obliteration of the sutures, the boundaries of the parietals cannot be seen.

The whole of the temporal fossæ may be seen in a back view of the cranium; they cannot be said to intrude on the plane of the occipital, but rather to bound the lateral portions of this surface. The summit of the occipital crest is flattened, and its lateral borders somewhat concave superiorly; there is a large tuberosity for the attachment of the nuchal ligament; the intercornual line is slightly concave; the superior border of the horn-cores is convex, and the inferior concave, as in the genus *Bos.*

The upper border of the temporal fossa is very nearly parallel to the lower or zygomatic border; the descending post-orbital process of the frontal is nearly vertical, forming almost a right angle both with the upper and lower borders of the temporal fossa; the inner wall of the temporal fossa is somewhat concave from above downwards, but is straight from before backwards. The maxillæ do not slope inwards to any great extent, so that the lateral surfaces of the nasals are nearly at right angles to the anterior surface. The skull is of great vertical depth from the orbit to the palate.

On the spheno-palatine surface the basi-occipital extends forwards for a short distance in the plane of the palate; at the anterior tubercles, however, it is bent

sharply on itself; the anterior tubercles are small; the interval between the posterior tubercles is not greater than that between the anterior pair. The posterior tubercles are the larger of the two, and the basi-occipital is triangular as in the oxen, but the tubercles are larger and with a more distinct median groove, as in the antelopes.

The palate is long and narrow, and but slightly arched; the palatines are produced backwards for a distance of one and a quarter inches behind the last molar, before their division. The molar series is much curved from before backwards; in front of the premolars the maxillæ are deeply grooved longitudinally. The molars are characterised by a very large accessory tubercle on the inner side; by the enamel islands being elongated posteriorly, and by the island of the posterior lobe being deeply indented from the same side by an enamel fold; the costæ on the dorsa of the teeth are slight, and the whole covered with a very thick coating of cement. The length of the last molar is 1·6 inches and its width 1 inch.

The maxillo-palatine suture is placed entirely in advance of the posterior palatine foramina; on the outer side it commences at the level of the penultimate molars, and passes inwards and forwards, so that in the median line of the palate it is on a level with the interval between the first and second molars. The posterior free border of the palatines is entire, and not bisected by the vomer.

A fragment of the proximal extremity of the premaxilla of the right side is seen occupying the angle between the maxillæ and the nasals, showing that this bone was of the long type, as in typical species of *Bos* and in *Bubalus.*

The present cranium is distinguished from the crania of all species of *Bos* and *Bibos* by having the horn-cores placed on a ridge, which is situated below the plane of the occipital surface, instead of directly over it; by the peculiar form of the cross-section of the horn-cores; and by the plane of the occiput being entirely distinct from the plane of the parietals; from the former of the above genera the present cranium is further distinguished by the transverse diameter of the forehead being longer than the antero-posterior diameter, and by the facial portion being consequently longer than the frontal portion; from the latter genus it is also distinguished by the convexity of the upper border of the horn-cores.

From the genus *Bubalus* this cranium is distinguished by the frontals being slightly concave instead of convex, by the superior border of the horn-cores being convex instead of concave, and by the form of the nasals and of the occipital surface.

The cranium agrees with the crania of the genus *Bison* in having the horn-cores placed below the plane of the occiput; it is, however, distinguished from the crania of that genus by the approximation of the horn-cores at their base, by their pyriform cross section, by the fact of no portion of the occipital crest being visible in a front view of the skull, and by the convexity of the upper border of the horn-cores.

It is quite clear, therefore, that this species cannot be included in any of the above genera: the only species with which it seems to have any affinity is *Bos acutifrons,* the horn-cores of the two having a pyriform cross section.

In the approximation of the bases of the horn-cores, and in the separation of the occipital and parietal planes, the skull makes some approach to the skulls of the goats; the position of the highest point of the frontals, almost midway between the orbit and the occiput, is an antelopine character; the large size and distinctness of the posterior tubercles of the basi-occipital is also a character of that group; the general form of the basi-occipital, however, and the structure of the teeth, is essentially Bovine.

Genus: HEMIBOS, *Falconer.*

This genus was made by Dr. Falconer for the reception of an aberrant Bovine cranium from the Siwaliks; the name, however, only has been published, no description having ever appeared.

The genus may be shortly defined as follows, from the characters of the cranium:—

Frontals concave, broader than long: horn-cores triangular in cross-section, short and straight, situated below the occiput on a high ridge of the frontals; occipital and parietal planes distinct: facial longer than frontal portion: orbit and horn-core approximated. Teeth and basi-occipital of the Bovine type.

Hemibos triquetriceros, *Falconer.* Pls. 22 and 23.

Figures of the cranium of this species have been engraved among the unpublished plates of the "Fauna Antiqua Sivalensis" (*Plate H*), and a few measurements are given in the accompanying index; another figure of the cranium will be found in Royle's "Himalayan Botany" (*Plate VI, fig.* 5): no detailed description has, however, appeared.

The cranium figured here (*Plates XXII and XXIII*) was collected by Major Godwin-Austen in the Siwaliks of the Markanda River; the greater portion of the specimen is complete, though somewhat weather-worn; about one-half of the left horn-core remains, while the whole of that of the right side is broken away: the distal portion of the maxillæ, together with the whole of the premaxillæ and the nasals, are also wanting. The palate is nearly free from matrix, and shows the roots of the molar series of either side, the crowns of all the teeth having been broken off close to their alveoli; the spheno-palatine region is somewhat imperfect. The cranium is that of a fully adult animal, nearly all the sutures having been obliterated.

If we turn to the profile view of the cranium given in the accompanying lithographs (*Plate XXIII*), we find this aspect to be totally different from the corresponding aspect of the crania of any of the Bovines described above, and, as will be more fully noticed below, approaching the form of the crania of the goats.

The horn-cores are very closely approximated at their base, and are placed on the summit of a high ridge, formed by the junction of the very distinct planes of the parietals and frontals; the former bones apparently form a distinct and broad band across the cranium behind the horn-cores, as in the sheep and antelopes, and are consequently much larger than in the oxen; the intercornual ridge is very far removed from the plane of the occipital surface; the horn-cores themselves have a triangular transverse section, which forms very nearly an equilateral triangle; their internal surface is placed nearly antero-posteriorly, and the external border immediately above the orbit; their direction is upwards, outwards, and a little backwards, diminishing regularly and somewhat rapidly in diameter, without any curve or twisting; their anterior border is continuous with the plane of the frontals: the base of the horn-cores is situated directly over the anterior half of the temporal fossa, leaving the posterior half uncovered above; there is a very short interval between the base of the horn-core and the adjacent border of the orbit. The orbits are somewhat worn and broken in this specimen, but naturally, as shown in other specimens, are non-salient, somewhat depressed below the general plane of the frontals, and having their antero-posterior diameter rather longer than their transverse diameter. From behind the orbit the temporal fossæ gradually increase in depth, and curve round on to the plane of the parietals, so that they are closely approximated at this point, the parietals being proportionately narrow. From the very forward position of the horn-cores and intercornual ridge, the antero-posterior diameter of the frontals is very short, considerably less than the transverse diameter (*see table of measurements given on page 66*). The cranium is but very slightly constricted in width, either above or below the orbits, the front view showing an almost complete parallelogram; the intercornual ridge is deeply concave; this concavity extends downwards to the middle of the frontals; there is a high rounded prominence on the inner side of the orbit: below this there is an oblique channel running outwards and downwards from the frontal hollow, while the apex of the nasals again rises as a prominent pyriform swelling; the apex of the nasals extends upwards on the forehead, as high as the lower third of the orbit. On referring to Falconer's figures of the cranium of this species in the unpublished plates of the "Fauna Antiqua Sivalensis," we find that the facial portion is double the length of the frontal portion; the nasals are widest at their infra-orbital angle, and the premaxillæ are of unusual length, and extend upwards between the nasals and the maxillæ.

There is a prominent angle leading from the orbit to the nasals; and the lateral surfaces of the maxillæ are nearly parallel and of great depth.

The anterior angle of the horn-core runs downwards as a kind of buttress on to the surface of the frontals; the base of the horn-core is burred.

Turning to the parietal and occipital regions of the cranium, we find the two occupying entirely separate and distinct planes, the occipital plane being bounded superiorly by the occipital crest; the plane of the parietals forms an obtuse angle with the planes of the frontals and the occipital.

Owing to the obliteration of the sutures in all the specimens, the exact boundaries of the parietals cannot be determined; the anterior boundary must, however, have been somewhere close to the posterior angles of the horn-cores, so that the parietals formed, as I have said, a broad transverse band across the skull, as in the antelopes and goats, the frontals being similarly bent on themselves at the intercornual ridge.

The occipital crest forms a wide arch, somewhat flattened above, for a distance of half the width of the cranium; the tuberosity for the attachment of the ligamentum nuchæ is large and distinct; there is a median ridge, dividing the part of the occipital surface above the foramen magnum, for the attachment of the intermuscular septum of the recti and other occipito-vertebral muscles. The occipital condyles are of large size; the space for the attachment of the digastric muscle is very narrow; the form of the paroccipital processes is not shown in our specimens.

The supra-orbital foramina are situated far apart from each other, and pierce the frontals at right angles; there is scarcely any sulcus below them; there are no infra-orbital sinusus or fissures as in the true antelopes.

The palate is highly arched from side to side, and but slightly produced behind the last molars; the molar series are placed nearly parallel to each other; the posterior palatine foramina are situated at the level of the second molars, entirely behind the maxillo-palatine suture.

On the basi-occipital (*F. A. S. Plate II, fig. 6*) the posterior tubercles are placed immediately in front of the occipital condyles, without any intervening groove, and are far apart; the interval between their internal borders is very nearly equal to that between the external borders of the anterior tubercles: the anterior tubercles are the smaller of the two; the posterior are rounded; the basi-occipital is triangular in form, as in the oxen.

The dimensions of the specimen figured in Plate XXII are given below:—

	Inches.
From occipital crest to intercornual ridge	6·3
Width at superior border of orbits	6·8
„ contraction below orbits	5·4
„ „ above „	6·7
From lower border of foramen magnum to occipital crest	5·1
Width of occipital through petrosals	7·8
Height from palate to frontals at orbit	5·3
Interval between external angles of occipital condyles	4·0
„ „ occipital crest and posterior angle of horn-core	3·1
„ „ base of horn-core and orbit	1·8
Antero-posterior diameter of left orbit	2·7
Transverse „ „	2·5
Length of five molars	5·0
Greatest width of palate	2·7
Interval between outer surfaces of first molars	5·4
„ „ foramen magnum and last molar	7·8
Length of left horn-core fragment along anterior border	5·1
„ internal surface of base of left horn-core	3·5
„ anterior „ „ „	2·9
„ posterior „ „ „	3·4

	Inches.
Width of narrowest portion of parietals	2·4
Interval between supra-orbital foramina	3·1
Length of temporal fossa	6 8
„ intercornual ridge	3·0

The measurements of two other specimens of cranium of this species collected by Mr. Theobald from Siwalik strata are as follows :—

Width at superior border of orbits	8·0	7·9
„ constriction above orbits	7·2	0·0
Interval between occipital crest and intercornual ridge	6·3	5·0
Width of narrowest part of parietals	2·4	2·8
„ occipital through petrosals	7·2	7·6
Height from lower border of foramen magnum to crest	4·8	4·5
Interval between external angles of condyles	4·5	5·2
Length of intercornual ridge	1·7	2·2

From the above measurements it will be seen that the latter of these two specimens differ from the first specimen in having a wider and lower occipital region and larger occipital condyles; the occipital crest forms a lower and flatter arch. The parietals between the temporal fossæ are also wider, and the horn-cores are of smaller dimensions, and directed more outwards.

The specimen drawn in Plate H, fig. 6, of the unpublished plates of the "Fauna Antiqua Sivalensis" has the bases of the horn-cores set much farther apart than in any of the above specimens, the interval between them being nearly six inches in length.

The teeth of all the specimens in the Indian Museum are in a very imperfect and damaged condition, but a few of them show that they were provided with the accessory median tubercle so characteristic of the oxen.

We may now consider in what points the cranium of the present peculiar genus is related to allied groups of Ruminants; firstly, we find that the position of the horn-cores, which are placed on a ridge of the frontals far in advance of or below the plane of the true occipital surface, and almost directly above the orbits, together with the distinctness of the planes of the occiput and the parietals, distinguishes the genus from all the true oxen, both recent and fossil, and approximates it to the antelopes and goats. From the true antelopes, however, the cranium of *Hemibos* is distinguished by the form of its horn-cores; no recent antelope has triangular horns, although those of *Antilope cordieri* of the Miocene Tertiaries of Montpelier are angulated in front; it is also distinguished from this group by the non-depression of the facial surface of the lachrymals and by the absence of any trace of the infra-orbital vacuity.

Among the aberrant antelopes and their allies we find that the cranium of *Hemibos* at first sight presents a considerable general resemblance to that of *Tragocerus amaltheus* from the Miocene Tertiary of Attica;[1] in both genera the planes of the frontals and the parietals form an obtuse angle with each other, and

[1] Gaudry: "Animaux Fossiles et Geologie. de l' Attique." Pl. XLIX.

in both the molars have an accessory median column; the skull of *Tragocerus*, however, is distinguished by having the horn-cores placed more immediately over the orbits, by their cross-section being ellipsoidal, and by the general shortness of the face.

Turning now to the true goats and comparing the crania of the two species of *Hemitragus* with the cranium of *Hemibos*, we find that in both genera the plane of the occiput forms an acute angle with the plane of the frontals; in both the inter-cornual ridge is situated above the superior border of the orbit; while in both the horn-cores are triangular in cross section, and have their anterior border continuous with the plane of the frontals, and the parietals form a distinct transverse band across the skull behind the horn-cores. In both the horn-cores are approximated to the orbits, and the supra-orbital foramina have the same general position and relations; the horn-cores of *Hemibos* are, however, much wider apart at their bases than in any living goat, and are also distinguished by being straight.

The cranium of *Hemibos*, again, differs from that of any existing species of goat, in that the plane of that part of the frontals which is below the horn-cores forms an obtuse angle with the plane of the parietals and of that portion of the frontals which is behind or above the horn-cores; whereas in the goats and their allies these two planes are placed at right angles to each other.

Again, the presence of the median accessory tubercle in the molars of *Hemibos* separates the cranium of that genus from the crania of all recent goats; this accessory tubercle occurs in the molars of all the oxen, and in those of the larger deer; it is generally absent in the antelopes, but is found in the upper molars of the Gnu, and in those of *Antilope boodon*, and of *Tragocerus amaltheus* of the European Miocene; it is entirely absent in all species of goats and sheep.

Turning now to the basi-occipital of *Hemibos*, we find that this bone is wedge-shaped, and therefore is more Bovine that Antilopine or Caprine in character; the posterior pair of tubercles are considerably the larger of the two, and are separated by only a small interval from the occipital condyles, as in the oxen; the median groove, however, between the tubercles of either side is deeper than in the oxen, and more like the same part in the antelopes; in the latter group, however, and in the goats, the basi-occipital is wide and quadrate in shape, both pairs of tubercles are well marked, but the anterior pair are generally the larger of the two, and the interval between the two tubercles of opposite sides is nearly uniform; in the goats there is a considerable interval between the hinder pair of tubercles and the occipital condyles.

The nasals of *Hemibos* are narrow inferiorly, and taper to a point as in the goats and antelopes.

On the whole, it appears that *Hemibos* presents characters intermediate between the oxen on the one hand and the goats and the antelopes on the other, but that the majority of its affinities are with the oxen; while in the form of the horn-cores it is distinct from all.

GENUS: AMPHIBOS, *Falconer.*

This genus, as I have already stated in the introduction, was formed by Dr. Falconer upon the evidence of the crania of three species of oxen-like animals from the Siwaliks, of which species only one can be now recognised. As in the case of the preceding genus, no definition of *Amphibos* was ever given by Dr. Falconer; from the characters of the cranium it may be shortly defined as follows:—

Frontals flat or slightly hollow, broader than long: horn-cores rounded in front, angulated behind, long and porrect at first, placed below the plane of the occiput on a slight elevation of the frontals; parietals shorter than in last genus; facial nearly as long as the frontal portion; teeth of the Bovine type.

AMPHIBOS ACUTICORNIS, *Falconer.* Pl. 21, f. 1; Pl. 24.

Figures of the cranium of this species have been given in one of the unpublished plates of the "Fauna Antiqua Sivalensis," and a few notes are added in the accompanying index. We possess in the Indian Museum several crania which agree in form and size with Falconer's figures of this species, and which I have accordingly referred to it; the specimen of which a frontal view is given (Plate XXIV) was collected by Mr. Theobald from the Siwaliks of the Kangra district; with the exception of the greater part of the premaxillæ, which have been broken away, the whole of the facial and frontal portions of the cranium are complete; both horn-cores have been broken away near to their origin; the fragment of the horn-core remaining on the left side of the specimen has been damaged on its anterior surface, so that its true form is not shown; the occipital and spheno-palatine regions could not be cleared from the exceedingly hard matrix in which they are embedded; most of the cranial sutures are obliterated, and the permanent molars are much worn, showing that the cranium belonged to an adult animal.

A profile view of another specimen also from the Siwaliks is given on Plate XXI, Fig. 1. In the front view of the cranium the frontal and facial portions of the cranium are seen to be of nearly equal length; the frontals are somewhat broader than long, and depressed in the middle line; the orbits are salient and separated by a deeply excavated but short interval from the horn-cores; inferiorly the maxillæ contract suddenly below the orbits (in some specimens, however, this contraction is not so marked, and it may probably be a sexual character). The nasals are long and rounded; at their proximal extremity they reach about a third up the orbit; they are widest at their infra-orbital angles; they contract below this and again expand at their distal extremity. The horn-cores are situated on a ridge of the frontals above and behind the orbits, but considerably in advance of the plane of the occiput; they are separated by a moderate interval at their bases, the median line of the frontals being hollowed between them; from the fragments remaining in the

figured and other specimens the horn-cores appear to have been directed upwards, backwards, and outwards without curvature; in transverse section they are rounded anteriorly with a ridge posteriorly; their widest diameter is placed antero-posteriorly; a slight angulation forms their anterior border, which is continued upwards in the line of the face. Behind the intercornual ridge the frontals and parietals slope backwards to the occipital crest; the ante-cornual and post-cornual planes of the frontals form an obtuse angle at their junction; the post-cornual frontal plane and the occipital plane also form an obtuse angle at their junction.

The temporal fossæ are long and narrow, having a rounded distal border; the orbit is large, and has its antero-posterior diameter rather the larger of the two; from the antero-inferior border of the orbit there is a well marked ridge running to the maxillary tubercle above the second premolar.

The parietals, as in the last genus, form a distinct band across the cranium behind the horn-cores; the temporal fossæ extend slightly on to this upper surface of the parietals. The occiput, as in the antelopes, is entirely distinct from the parietals, no part of the latter extending on to the plane of the former. The occipital crest is well marked, and considerably overhangs the general plane of the occiput; the occiput is expanded laterally, and the crest and condyles are consequently approximated; the paroccipital processes are long and placed unusually close to the condyles.

On the palatal surface the lines of molars are placed rather far apart, and are nearly straight; the palate is vaulted and extends backwards considerably behind the last molars; the molars have a large accessory column. The basi-occipital is wedge-shaped, as in the typical oxen; the posterior tubercles are large, rounded, and scarcely separated from the condyles; the anterior tubercles are situated considerably in advance of the posterior pair; they are very small, elongated antero-posteriorly, and approximated.

The dimensions of the specimen drawn in Plate XXIV are as follows :—

	Inches.
Length from foramen magnum to diastema	12·0
„ „ occipital crest to apex of nasals	8·0
„ of nasals	7·8
Width at superior border of orbit	7·8
„ constriction below „	5·4
„ „ above „	6·5
From lower border of occipital foramen to occipital crest	5·0
Width of occipital through petrosals	8·3
Height from surface of palate to frontals	6·1
Interval between external angles of occipital condyles	3·9
„ „ occipital crest and superior angle of horn-core	1·2
Length of temporal fossa	5·5
Height from distal extremity of palate to surface of frontals	4·4
Interval between horn-core and orbit	2·2
Antero-posterior diameter of right orbit	2·4
Transverse „ „	2·0
Length of six molars of right side	5·4

	Inches.
Greatest width of palate	3·0
Antero-posterior diameter of base of right horn-core	3·6
Transverse „ „ „	2·4
Distance between outer surfaces of first molars	5·1

The specimen is distinguished from the last genus by the smaller diameter of the horn-cores; by the absence of a triangular cross-section of the horn-cores and by their more depressed direction; by the less backward projection of the occipital condyles; by the wider interval between the bases of the horn-cores; and the less excavated median line of the frontals between them; by the smaller interval between the intercornual ridge and the occipital crest; by the greater proportionate width of the transverse diameter of the frontals, and by the smaller elevation of the intercornual ridge above the base of the skull; the continuation of the line of the base of the molars cuts the occipital condyles in the present species, while in *H. triquetriceros* a similar line would cut the occiput considerably above its centre; the form and position of the horn-cores of *Amphibos* sufficiently distinguishes it from *Peribos.*

Dr. Falconer's remarks on the specimen of the occiput and horn-cores of this species figured in Plate I, figs. 2 and 2*a*, of the "Fauna Antiqua Sivalensis" are as follows: "The direction of the horns is more upright than in *Hemibos triquetriceros;* the horns are rounded on their anterior surface and flattened behind and taper to a point." The measurements of the specimen figured in fig. 3 of the same plate are as follows:—

	Inches.
Length of fragment	17·0
From occipital condyles to first molar	13·7
Length of molar series	5·4
„ three molars	3·3
Interval between external angles of occipital condyles	4·5
Height of occipital crest from foramen magnum	4·3
Width of skull below horn-cores	3·7 (?) or 5·7 (?)
„ between maxillary prominences	5·8
Breadth opposite sub-orbital foramina	4·1
Least width of nasals	1·4
Greater diameter of orbit	2·8

The above measurements correspond in the main with those of the specimen figured above; in the specimen figured in Plate I, (*lettered series*) fig. 2, of the "Fauna Antiqua Sivalensis," the horn-cores are complete and measure upwards of twenty-seven inches in length; this specimen belonged probably to a male.

In the distinctness of the parietal and occipital planes the genus makes an approach to the antelopes; the general form and direction of the horn-cores is also considerably more Antilopine than Bovine; the horn-cores are, however, further removed from the orbit than in the antelopes; the basi-occipital and teeth are distinctly Bovine, and the lachrymal is not depressed as in the latter group. Some specimens of crania, probably those of aged males, develope a protuberance of

the frontals below the bases of the horn-cores; this gives a somewhat convex profile to the frontals, the horn-cores, and the lower part of the frontals, sloping away on either side from the infra-cornual protuberance; in the figured specimen the profile is nearly straight.

Both this species and *Hemibos triquetriceros* are probably to be regarded as links between the true oxen and the Bovoid antelopes like *Portax, Oreas,* etc.; the latter group is, however, among other characters distinguished from the oxen by the absence of the accessory column in the molar teeth which the Siwalik genera possess; this group of animals is confined to India and Africa, only one species, however, *Portax picta,* now remaining in the former continent; in the Indian Tertiaries, besides the antelopoid oxen above described, there existed a true antelope, *A. palæindica,* which also presented some points of affinity to the African Bovoid antelopes; the above facts all tend to confirm the former common origin of the Ethiopian and Indian faunas; the more the Tertiary fauna of India is explored, the more forms do we find to be common to or to represent one another in the faunas of the two continents.

Table of Frontal Measurements of the Bovidæ.

The subjoined table shows the relative proportions of the antero-posterior and transverse diameters of the frontals of the crania of all the recent and fossil Indian bovoid animals. The transverse diameter is taken across the widest part of the cranium between the orbits, and the antero-posterior diameter is the interval between a transverse line connecting the centres of the orbits and the intercornual ridge. The corresponding diameters of the cranium of the European *Bos primigenius* are prefixed for comparison :—

	Trans. diam.	Ant.-post. diam.	Excess of trans. diam.	Excess of ant.-post. diam.
	Inches.	Inches.	Inches.	Inches.
Bos primigenius	9·4	10·5	...	0·9
Bos namadicus ♂	9·5	11·0	...	1·5
Bos namadicus ♀	7·5	8·4	...	0·9
Bos acutifrons	10·7	11·4	...	0·7
Bos planifrons	9·3	10·0	...	0·7
Bibos frontalis	11·0	9·5	1·5	...
Bibos gaurus	10·0	8·5	1·5	...
Bison (Poephagus) grunniens	10·0	6·5	3·5	...
Bison sivalensis	9·3	5·8	3·5	..
Bubalus platyceros	9·2	8·0	1·2	...
Bubalus arni	8·5	7·5	1·0	...
Bubalus palæindicus	11·1	9·9	1·2	...
Hemibos triquetriceros	8·0	3·5	4·5	...
Peribos occipitalis	7·9	5·0	2·4	...
Amphibos acuticornis	6·4	4·4	2·0	...

The measurements of the crania of the living species in the above table are taken from Mr. Hodgson's paper on the Genera of the Indian oxen in the Journal of the Asiatic Society of Bengal (Vol. X, p. 453).

Family,—ANTILOPIDÆ.

Genus: ANTILOPE.

As stated in the introduction to the present memoir, Dr. Falconer determined several species of antelopes from the Siwaliks, but only one of these, *viz.*, *Antilope palæindica,* is known by anything more than its manuscript name. Of *Antilope palæindica* there are figures of the cranium given in the "Palæontological Memoirs" (*Vol. I, Plate XXIII*), and in the "Journal of the Asiatic Society of Bengal" (*Vol. IV, Plate XLVIII, figs. 40, 41, and Vol. XII, p. 769, and figs. 1, 2, of accompanying plate*); the latter figure is accompanied by a short description from the pen of the late Colonel Baker. The characteristic points of the cranium of this species are the great elongation of the face, the concavity of the profile, the absence or small development of the infra-orbital sinus, and the small size of the supra-orbital foramina. The horn-cores are approximated at their bases and directed upwards, backwards, and outwards in a simple curve, without any twisting; they are slightly compressed laterally; the species seems to be allied to the African Hartebeast.

In addition to the above species, I am now able to describe three new species from the Siwaliks, founded upon specimens of the horn-cores or crania which are in the collection of the Indian Museum; the figured specimens were all obtained by Mr. Theobald.

Several of the crania of the Siwalik antelopes differ considerably from the type forms of the genus, and should probably be placed in distinct genera or subgenera; I have thought it best, however, for the present to retain them under the type genera.

Antilope Sivalensis, n. sp. Pl. 25, fs. 1 & 2.

This species is founded on a cranium obtained from the Siwaliks of the Kangra district; it corresponds with the two less complete specimens in the collection of the Asiatic Society of Bengal catalogued by Dr. Falconer (Nos. S. 569, 573).

This cranium is in a somewhat cracked and shattered condition, as is so commonly the case with Siwalik fossils; the two horn-cores are broken off shortly above their origin from the frontals; the greater part of the nasals is also broken away, and the borders of both orbits are crushed; on either side the whole extent of the zygomatic arch has been destroyed. The occipital condyles, together with the greater part of the boundary of the foramen magnum, are likewise absent; the premaxillæ and the extremities of the maxillæ are abruptly broken off; they have been restored in outline in the profile view. The crowns of the ultimate molar teeth are broken off close to their alveoli.

The cranium is slighter larger than that of the living Indian *Antilope cervicapra*, a figure of the cranium of which species will be found in the "British Museum Catalogue of Ungulates," 1853 (*Plate VIII, fig. 3*). The horn-cores of *Antilope sivalensis*, if, as is almost certainly the case, the cranium (No. S. 573) in the Asiatic Society's collection belongs to this species, were not spirally twisted; otherwise the general form of the crania of *A. sivalensis* and *A. cervicapra* is almost identical, and the two animals were no doubt very closely allied. Most of the sutures in the present specimen are still visible, and the outline of the component bones can therefore be determined with exactness.

The inclination of the basi-cranial axis in the cranium of *Antilope sivalensis* forms a rather smaller angle with the plane of the palate than in the recent species; and consequently the whole of the cranial portion of the skull is placed more below the level of the palatal plane. In *Antilope cervicapra*, if the line of the outer border of the molar alveolus be produced backwards, it will be found to cut the lower extremity of the occipital condyles; in the cranium of *Antilope sivalensis* a similar line will cut the occiput immediately above the foramen magnum. In the same manner the aperture of the meatus auditorius externus in the recent species is placed very slightly below the dental border of the orbit, while in the fossil species the same aperture is placed very considerably below the corresponding orbital boundary.

The occiput in both species is identical in form, being bounded above by the very prominent and overhanging crest or superior curved line, and having a large tuberosity for the attachment of the ligamentum nuchæ; the supra-occipital is, however, rather narrower in the fossil species, the indentations of the temporal fossæ extending to a rather larger extent on to the superior surface of the cerebral chamber. The parieto-frontal suture in both species forms a doubly curved line across the skull, immediately behind the horn-cores. Externally to the horn-cores the superior surface of the orbit in the recent species forms a flat surface placed at right angles to the outer surface of the horn-core; in the fossil species the two surfaces slope imperceptibly one into the other, without any angulation at the junction. As far as can be judged from its broken condition, the orbit of the fossil species seems to have possessed the same straight dental border which is characteristic of the recent species.

The concavity which occurs between the orbits, immediately below the horn-cores in *Antilope cervicapra*, is wanting in *Antilope sivalensis*, this surface being plane, and without any ridge running obliquely from the horn-core to the orbit. The horn-cores of *A. sivalensis* rise nearly vertically from the frontals, with a small interval between their bases, the supra-orbital foramina pierce the bases of the horn-cores, and have no large sinus at their mouth. The nasals extend upwards nearly to the middle of the orbits; the plane of the frontal is nearly at right angles to that of the lachrymal; there is a notch in the anterior border of the orbit at the commencement of the lachrymo-frontal suture: the lower extremity of the frontal

forms a triangular process fitting in between the nasals and frontals; at the junction of the lachrymo-frontal, naso-frontal, and naso-lachrymal sutures there is a small elongated fissure representing the larger infra-orbital vacuity of other antelopes. The facial surface of the lachrymal is much depressed. The maxillæ have a large tuberosity above the second molar. With the exception of the direction of the horn-cores and the smaller size of the supra-orbital sinuses, the whole of the above characters exactly correspond with those of the cranium of *Antilope cervicapra.*

On the inferior aspect the basi-occipital is rather different from that of the recent species: the posterior tubercles are nearly similar in both; the anterior pair of tubercles in the recent species are very large, and nearly three quarters of an inch in height, and are separated by a long interval from the posterior pair; in the fossil species the two pairs of tubercles are more closely approximated, and the anterior pair are but very slightly raised above the surface of the basi-occipital: in consequence of their small size the whole basi-occipital becomes somewhat triangular in form. By the approximation of the two pairs of tubercles the tympanic bulla appears to be placed more anteriorly than in the recent species, being partly in advance of the anterior border of the first pair of tubercles, whereas in *A. cervicapra* it does not extend farther forward than the middle of these tubercles.

The palate of the fossil species is considerably wider in proportion to its length than in the recent species; the embedded crowns of the molar teeth also show a greater width in proportion to their length, the grinding surface being probably nearly square instead of oblong. Whether the maxillæ presented the peculiar sickle-like edges on the palatal surface, which are found in the recent species, we are unable to say from the present specimen.

The measurements of this cranium are given with those compared below with those of a cranium of an adult specimen of *Antilope cervicapra*:—

	A. cervicapra. Inches.	*A. sivalensis.* Inches.
Width at superior border of orbits	4·30	5·20
„ inferior „ „	3·40	4·10
Interval between outer surfaces of horn-cores at base	3·40	4·10
„ „ bases of horn-cores	1·00	0·90
„ „ superior angles of supra-orbital foramina	1·70	2·10
Direct distance between extremities of inter-frontal suture	2·60	3·50
Interval between middle of fronto-parietal and occipito-parietal sutures	2·00	2·20
„ „ inferior border of foramen magnum and summit of occipital crest	1·80	2·49
„ „ occipital crest and occipito-parietal suture	0·70	0·90
Greatest width between temporal fossæ	2·70	3·20
Width of occipital through petrosals	3·40	3·80
Interval between meatus auditorius and orbit	1·70	2·10
Antero-posterior diameter of right orbit	1·70	2·10
Transverse „ „	1·50	1·70
Interval between inferior border of foramen magnum and palate	3·60	4·30
Width of palate between last molars	1·50	1·80
Interval between outer sides of last molars	2·30	3·40
Length of three last molars	1·60	2·20
„ last molar	0·65	0·80
Breadth „	0·45	0·65
Circumference of base of right horn-core	3·80	4·90

It will be seen from the above that the proportions of the crania of the two species are very similar, but the differences noticed above are sufficient to distinguish between the two.

The fossil cranium differs very markedly from that of *Antilope palæindica* of Falconer; it is much smaller in size, the horns differ in form, position, and direction, while the facial and nasal portion are much smaller in proportion to the frontal; the profile of *A. palæindica* is concave, while it is nearly straight in the new species; the orbit of the former is entirely behind the molar series, and above it in the latter species the supra-orbital foramina are very minute, and without a sinus in *A. palæindica*, while in *A. sivalensis* they are large. It is quite probable that the latter may have been the progenitor of the living Indian antelope, the twisted horns of the living species being a recently acquired character.

Antilope patulicornis, n. sp. *nobis*. Pl. 25, f. 3.

This the third fossil Indian species of the genus is founded on the imperfect frontlet figured in Plate XXV, fig. 3, collected by Mr. Theobald in the Siwaliks. Though in a very imperfect state, the specimen is very distinct from either of the other two Siwalik antelopes; indeed it is more than probable that it should not be referred to the restricted genus *Antilope* at all, but should rather be placed in a separate genus; its affinities, however, are mostly Antilopine, and I have therefore placed it in the type genus, until more complete specimens enable us to define its position more exactly.

The specimen comprises the greater portion of the frontal bones with a portion of the horn-core of the left side; on the posterior surface the greater part of the orbital cavities and the anterior extremity of the cerebral cavity are preserved.

The horn-cores are placed at a short distance above the orbits, and have a considerable interval between their bases; the frontal suture forms a somewhat elevated median line, with a longitudinal hollow on either side. At a short distance above the border of the orbit there is a very large supra-orbital fossa, triangular in shape; at the superior angle of this fossa, the frontal is pierced by a supra-orbital foramen, circular, and of unusually large size; it passes directly through the frontal into the cavity of the orbit.

The horn-cores present an ellipsoidal cross-section; they are longitudinally marked by parallel ridges and grooves: their general direction is upwards, backwards, and outwards, in a single gentle curve; their anterior surface is convex and the posterior concave; there is a faint trace of a spiral arrangement of the grooves on the cores; the diameter scarcely diminishes at all, in the fragment preserved, towards the extremity. The frontals are of considerable thickness, with finely cancellated structure between the outer and inner tables.

On the posterior aspect the specimen shows the anterior part of the cerebral cavity, as far down as the commencement of the cribriform plate of the ethmoid;

this part of the cavity is triangular in shape with a slightly vaulted roof, with well-marked "*impressiones digitatæ;*" the orbital cavity is smooth and rounded, and pierced by the supra-orbital foramen. The dimensions are as follows:—

	Inches.
Interval between base of horn-core and orbit	0·9
„ „ bases of horn-cores	2·0
Thickness of frontal	1·0
Antero-posterior diameter of left horn-core	1·8
Transverse „ „	1·6

The presence of the large supra-orbital fossa and foramen, the latter passing directly from the surface of the frontal into the orbit, at once separate the specimen from the sheep and goats, in which the foramen is small and has a sinuous course, and there is no fossa present: the horn-cores also taper much less than in any goat or sheep of the same size.

The concavity of the frontals between the horn-cores and the raised frontal suture is an Antilopine character; the horn-cores are placed on the frontals at a considerable distance apart, but not more so than in *Saiga tartarica;* from their nearly uniform diameter they were probably of considerable length; their ultimate direction cannot be determined from this specimen; if continued outwards in the same manner as the part remaining, they must have differed considerably from those of any existing species of antelope; possibly they were suddenly bent inwards after a certain distance, as in *Alcelaphus.*

ANTILOPE PORRECTICORNIS, n. sp. *nobis.* Plate 25, f. 4.

A large number of frontal bones and horn-cores of a species of antelope different from any of the above have been collected by Mr. Theobald from the Siwaliks of the Potwar district; no complete crania have hitherto been discovered; for this species I propose the name of *A. porrecticornis.*

The specimen figured is the frontal bone, and the greater portion of the horn-core of the left side; the right side has been restored in outline. The frontal is strongly arched, and excavated longitudinally between the prominent suture and the base of the horn-core. The supra-orbital foramen is enclosed by a large pyriform sulcus, its extremity reaching almost up to the base of the horn-core. The horn-core is placed immediately above the orbit, and is separated by only a short interval; the diameter of the horn-core is at first upwards, outwards, and backwards, and then curves inwards towards its extremity; the transverse section is oval, the horn-core being compressed laterally. The measurements of the specimen are as follows:—

	Inches.
Length of frontal suture	2·40
Width of frontal „	1·85
Length of fragment of horn-core	4·50
Antero-posterior diameter of base of horn-core	1·60
Transverse „ „ „	1·15

The compressed horn-core and the large supra-orbital sinus approximate this species to the Gazelles ; it is, however, distinguished from the living species of that genus by the inner border of the horn-core being concave instead of convex, by the frontal being proportionately shorter, and by the supra-orbital sinus being wider and more open at the base.

The species is distinguished from *Antilope palæindica* by the horn-cores being placed wider apart at the base, by their curvature and direction, and by the presence of the large supra-orbital sinus and foramen.

With the frontlet of *Antilope patulicornis* the present specimen presents no points of resemblance.

From *Antilope sivalensis* the specimen is distinguished by its smaller size, and by the direction of the horn-cores, which rise vertically from the frontals in that species; further, the supra-orbital sulcus and foramen are entirely distinct from the horn-core in the present specimen, while in *A. sivalensis,* they are situated on the base of the horn-core ; the sulcus also is much larger, and the frontal shorter in the present species.

If the complete cranium be ever discovered, I imagine that it will be found to correspond in general character with the crania of the Gazelles, among which group I think the species should probably be placed.

Family,—SIVATHERIDÆ.

Genus: HYDASPITHERIUM, nov. gen. *nobis.*

This genus of Sivatheroid animals was originally erroneously named *Hydaspidotherium ;*[1] the characters of the genus will be gathered from the description of the cranium on which it is founded. It may not be out of place to state here that several lower jaws and detached molars have recently been obtained from the Punjáb, which indicate the former existence of other species.

Hydaspitherium megacephalum, nov. sp. *nobis.* Pls. 26 & 27.

The magnificent cranium figured in the accompanying plates is perhaps one of the most interesting of the fossils discovered by Mr. Theobald in the Siwaliks of the Punjáb ; it belongs to that strange group of animals represented in the Tertiary period of India by *Sivatherium, Bramatherium,* and *Vishnutherium,* a group which connects the still living and isolated genus *Camelopardalis* with other families of the order. The distribution of this group in India, as far as we can at present judge, is peculiar : *Sivatherium* seems to have ranged from the Dehra Dun district as far as the eastern side of the Punjáb ; in the Western Punjáb its remains

[1] Rec. Geol. Surv. Ind., Vol. IX, p. 154.

seem to be unknown: *Hydaspitherium* has been found only in the Potwar district of the Punjáb, while *Bramatherium* is confined to Perim Island, and the smaller *Vishnutherium* to Burma; *Camelopardalis* has been found throughout the greater part of the Sub-Himalayan Siwaliks, and it also occurs in Perim Island. Of course these lines of distribution may by subsequent discoveries have to be modified, but they seem to point out that the head-quarters of the different genera had each its separate area, and that it was chiefly stragglers that intruded into the area of another genus.

Before describing the present specimen, it is necessary to say a few words regarding the allied genus *Bramatherium;* this genus was founded by the late Dr. Falconer upon the evidence of certain upper molar teeth of a large ruminant from the mammaliferous beds of Perim Island in the Gulf of Cambay; these teeth were figured and described in the Quarterly Journal of the Geological Society of London for 1845 (*Vol. I, p. 356*); these figures, together with the description, have been copied in the "Palæontological Memoirs" of Dr. Falconer, (*Vol. I, p. 389*); the lower molars of the same species have been figured and described in the foregoing part of the present Memoir.[1] These molar teeth are the only remains which have been described under the name of *Bramatherium;* there is, however, a cranium of a large ruminant from Perim Island, allied to *Sivatherium* and *Camelopardalis* described and figured by its discoverer, Mr. Bettington, in the Journal of the Royal Asiatic Society for 1845 (*Vol. VIII, p. 340*); an additional note on the specimen by Professor Owen will be found in the same volume (*p. 417*); no name was assigned to the specimen either by its discoverer or by Professor Owen, though the latter seemed inclined to place it in the genus *Sivatherium.* At the time of writing his own Memoir on the teeth of *Bramatherium,* Dr. Falconer had not seen Mr. Bettington's Memoir, both memoirs being published during the same year; in a postscript, however, Dr. Falconer mentions having seen an abstract of Mr. Bettington's Memoir, and suggests that the specimen there described might possibly belong to the then new genus *Bramatherium.* Unfortunately, Mr. Bettington has not given the measurements of the molar teeth of his specimen, so that it is not possible to compare these teeth exactly with Dr. Falconer's specimens; there is, however, in Mr. Bettington's Memoir a half-sized figure of the molars of his specimen, and on comparing this figure with the figures of Dr. Falconer's specimen, I find that the two correspond exactly both in size and form. On this ground, and as both specimens are from the same locality, I have no doubt but that Mr. Bettington's specimen is really *Bramatherium perimense,* and I shall so consider it in the present Memoir. That cranium is characterised by being provided with two pairs of horn-cores, the posterior pair of which arose from the sides of the occipital crest, on distinct bases, and were directed outwards and backwards; while the anterior pair took their origin from a common base situated a short distance

[1] Pp. 42—60, Plate 7, fig. 13.

above the orbits; these horn-cores were directed upwards and outwards; their common base was constricted at its origin: the frontals were laterally contracted above the orbits, and the face presented a slightly convex profile: the molar teeth want the crenulated folding of the enamel of the inner semi-circle of the islands found in the teeth of *Sivatherium*, and have a minute accessory tubercle in the valley dividing the inner sides of the two barrels.

To return to our own specimen. We find that the cranium itself is almost complete, though the horn-cores have been broken off at their base; the extremities of the nasals, maxillæ, and premaxillæ are also wanting. The crowns of the first premolars have been broken off at their bases.

The cranium is that of a fully adult animal, most of the cranial sutures having become obliterated, and the molar teeth being about one-third worn down. Like the crania of the allied genera, the present specimen is remarkable for its general massiveness and bulk: at the line of fracture the frontals are produced into an enormous mass of bony structure, which formed a common base for one or more pairs of horn-cores; this base measures as much as thirty-four inches in circumference; the profile of the face is very markedly concave, with an obtuse re-entering angle at the junction of the frontals and nasals; there are no horns immediately over the orbits. The orbit, as in the allied genera, is placed very low down on the skull, far removed from the plane of the face; its antero-posterior diameter is longer than its transverse diameter, and its central axis is directed outwards and forwards, so that its zygomatic border is considerably more prominent than its frontal border; a complete bony ring surrounds the orbit, which is small in comparison to the size of the cranium. The nasals are short and straight, extending as far upwards as the lower border of the orbit; they seem to have been narrower than those of *Sivatherium*, and have no trace of the arching found in those of that genus; in the specimen the greater part of the nasals are broken away, but a cast of their inner surface remains; from this fracture and from the obliteration of the cranial sutures, it is not easy to determine the precise relations of the nasals to the surrounding bones; it seems, however, to be quite clear that the nasals articulated with the maxillæ, though probably not with the premaxillæ. There does not seem to be any resemblance in the form of the nasals and frontals to those of *Saiga*, with which Dr. Murie[1] has sought to affiliate *Sivatherium*, chiefly on account of the form and relations of the nasals: in the present cranium the anterior nasal orifice is comparatively small, and bears no resemblance to the enormous orifice of *Saiga*, neither do the nasals reach to the median line of the orbits as in the latter genus, but, on the contrary, are completely below the orbits. The superior surface of the nasals forms an obtuse angle with the frontal plane; this angle is larger than in *Sivatherium*; the anterior nasal orifice presents an approximately circular transverse section, the transverse diameter being rather the larger of the two; the foramen for the maxillary branch of the fifth nerve is of rather large

[1] Geol. Mag., Vol. VIII, p. 44.

size, and pierces the maxilla immediately above the first premolar: the position of this foramen on the anterior and not on the lateral surface of the maxilla is like what occurs in *Camelopardalis;* between the nasals and the orbit there is a large vacuity shaped like an isosceles triangle, of which the apex is directed upwards and outwards, while the base is nearly horizontal; there is no depression of the surface of the lachrymals below the orbit as so commonly occurs in the antelopes; in the absence of this depression the cranium agrees with *Camelopardalis;* the exact relations of the lachrymal to the surrounding bones cannot be determined, but the former seems to have been of considerable relative size. Below the orbits the skull gradually contracts in width down to the molar alveoli; the maxillæ are of great depth from the orbits to the molars; this character is more Bovine than Antilopine or Giraffine: the lateral surfaces of the maxillæ are nearly even, with the exception of a large conical tuberosity above the penultimate premolar. Above the base of the nasals the frontals rise nearly vertically upwards, with a smooth facial surface, which gradually widens above; immediately over the orbits the whole skull is contracted in width for a length of several inches; at the point of fracture of the specimen the skull has again expanded nearly to its original width: the mass of cancellous bone which formed the base of the horn-cores does not show any sign of a median fissure, and the horn-cores probably did not diverge from their common base until a considerable distance above the plane of the frontals, as in *Bramatherium.*

On the lateral surface of the cranium we find a deep and wide temporal fossa bounded superiorly by a well-marked ridge which extends backwards from the orbit along the base of the horn-cores; a short distance behind the orbit there is a small tuberosity on this ridge; the temporal fossa is open from above. The zygomatic process of the squamosal is indented near its origin, and then suddenly bends outwards to form the large glenoid cavity, the tympanic is compressed and without a bulla; the meatus auditorius externus is directed outwards, and closely approximated to the paroccipital process; in the above characters this skull agrees with that of *Camelopardalis* and differs from the skulls of the Antelopes: the junction of the jugal with the zygomatic process of the squamosal is more prominent than any portion of the orbit.

The occiput is remarkable for its great size and flatness, affording a large surface for the attachment of the muscles necessary to support so large a cranium; the plane of this surface forms an obtuse angle with the plane of the frontals; in shape the occiput is rudely oblong, with its superior border arched; the transverse diameter is longer than the vertical diameter; above the foramen magnum there is a deep and nearly circular hollow of large size for the attachment of the ligamentum nuchæ; this hollow is divided by a vertical median ridge: strong ridges directed upwards and outwards run from the foramen magnum below the ligamental fossa to the periphery of the occiput. The foramen magnum is of large size, and extends upwards considerably above the level of the condyles; its axis is almost perpendicular to the plane of the occiput, and its vertical diameter is the larger of the two:

the occipital condyles are placed high up on the occiput, and their long axes are nearly horizontal. The paroccipital processes are of enormous width, forming flat bony plates extending from the foramen magnum to the lateral borders of the occiput. Above the occipital crest the common base of the horn-cores rises almost vertically, somewhat after the manner of the intercornual ridge of the oxen. It is impossible to say how much of this portion of the cranium is formed by the parietals and how much by the frontals, but I am inclined to think that in the middle line the parietals formed a very narrow strip as in the true oxen; there is no trace of any horn-cores joining the occiput as occurs in the cranium of *Bramatherium.*

On its palatal aspect the cranium, like that of *Sivatherium*, is remarkable for the great relative width of the portion behind the molar series; the outline of this aspect of the skull presents the form of a blunt wedge, instead of the elongated wedge which usually occurs in this aspect of the skulls of the other genera of Ruminants. In consequence of the direction of the foramen magnum, a palatal view of the condyles shows that these are separated only by a very narrow notch, scarcely any part of the foramen magnum itself being visible from below. The shape of the basi-occipital and sphenoid is that of an elongated wedge; the former bone bears two pairs of tubercles; the posterior pair are very small, closely approximated to the occipital condyles, and separated from each other by a considerable interval: the anterior pair are of much larger size; they are narrow, approximated to each other, confluent anteriorly, and have their free extremities directed backwards; between these tubercles and the glenoid cavity on either side is the foramen ovale in its normal position; most of the other foramina are concealed by matrix, though the foramen lacerum posterius may be distinguished at the base of the paroccipital process. The plane of the basi-cranial axis is unbroken, and is almost parallel to the plane of the palate; in this important character the skull resembles the skulls of *Camelopardalis* and the deer, and differs widely from the skulls of the antelopes, sheep, goats, and oxen, in which the basi-cranial axis forms a considerable angle with the plane of the palate. The free margin of the palatines forms in the middle line a wide semicircular notch, which extends as far forwards as the penultimate molar, a character very unusual among Ruminants; the palatine foramina are placed on the same line as the fore barrel of the penultimate molar; the palatines are more like those of the Giraffe than any other Ruminant: whether they terminated on the median line in a point, as in the antelopes and sheep, or whether in a re-entering angle as in the Giraffe, is not shown in the present specimen. The palate is relatively wide, and the lines of the molars are nearly straight; behind the last molars the maxillæ and jugals diverge rapidly outwards: the glenoid cavity is wide, and has a large and slightly recurved post-glenoid process.

The teeth of this genus have the same general form as those of the allied genera, and the enamel has the same general rugose character, though the sculpturing is rather finer; apart, however, from their smaller size these teeth have

certain distinctive characters of their own. The specimen figured (*Plate 27, fig. 4*) is the ultimate upper molar of the left side; I have also figured for comparison the penultimate left upper molar of *Sivatherium giganteum* (*fig. 3*); both specimens are of the natural size; figures of the left upper molars of *Bramatherium perimense* will be found in the "Palæontological Memoirs" (*Vol. I, plate XXXIII*).

The upper molar teeth of *Hydaspitherium* have no waving or crenulation of the enamel in the central crescent of the crown, by which negative character they are at once distinguished from the molars of *Sivatherium*: the central infolds of enamel in *Hydaspitherium* are remarkable for their great size and for the depth of the central portion, so that even in the present much worn state of the specimen, the two infolds are still connected by a deep channel, and they would not become completely insulated until the tooth were worn down almost to its base; in Falconer's figures of the upper molars of *Bramatherium*, which are in about the same state of wear as the present specimens, the central enamel folds are completely insulated. The posterior enamel fold is produced into a peculiar projection at its postero-internal angle; the antero-external angle of the inner half of the hind barrel is produced into the central hollow of the fore barrel; the fore barrel is the larger of the two; the outer surfaces are placed very obliquely to the antero-posterior axis of the crown, the anterior costæ on the dorsa of the barrels forming the most prominent points on the outer border of the crown; the median costæ are very slight, which is another point of difference between these teeth and those of *Sivatherium*. In the inner valley dividing the two barrels there is a very small tubercle attached to the hinder barrel only: a similar tubercle occurs in the molars of *Bramatherium*, but not in those of *Sivatherium*: on the anterior surface of the tooth there is a slight but well marked cingulum: a similarly placed cingulum occurs in the molars of *Sivatherium*, but not in those of *Bramatherium*. The teeth of *Bramatherium* are rather larger than those of the present genus, while those of *Sivatherium* are much larger than either. The molars of *Hydaspitherium* in general form are very like those of *Helladotherium* from the upper miocene of Attica, but are distinguished by the presence of the small accessory tubercle in the median internal valley.

The following table gives the measurements of the specimen: the measurements of the crania of *Sivatherium*, *Bramatherium* and *Camelopardalis* will be found in the above-quoted paper of Mr. Bettington:—

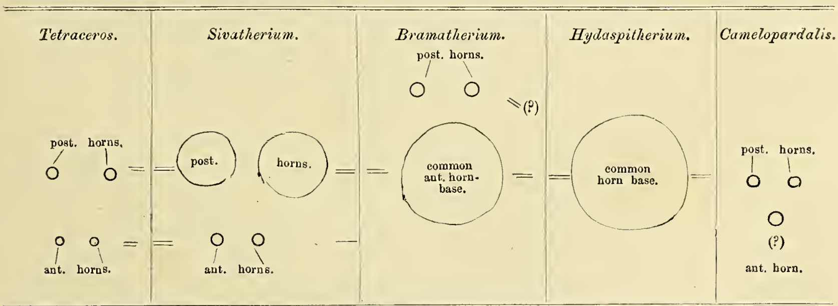
	Inches.
Length from foramen magnum to diasterna	16·60
" " " fractured muzzle	17·80
" " " last molar	9·35
Length from fractured extremity of nasals to highest point of cranium	18·00
" " inferior border of orbit to first premolar	6·20
" " superior " " occipital crest	10·20
Width at anterior border of orbit	10·50
" posterior " "	12·40
" constriction above orbits	8·10

	Inches.
Width across zygomatic arches	13·30
„ „ tuberosities of maxillæ	10·30
„ in front of first premolar	5·00
Depth from palate to root of nasals	7·00
Interval between orbit and fractured summit of frontal (right side)	6·50
Width of occiput across paroccipital processes	11·40
Interval between inferior border of foramen magnum and occipital crest	7·30
„ „ occipital crest and fractured summit of frontals	3·80
Width above occipital crest	7·70
„ across temporal fossæ	6·30
Interval between external angles of occipital condyles	5·40
Length of right occipital condyle	3·10
Vertical diameter of foramen magnum	2·40
Transverse „ „ „	1·90
Vertical diameter of left orbit	2·60
Transverse „ „	2·80
Interval between foramen magnum and posterior basi-occipital tubercles	2·70
„ „ posterior basi-occipital tubercles	0·60
„ „ foramen magnum and free border of palate	11·40
Width of palate at last molar	4·90
„ „ second premolar	4·20
Interval between outer surfaces of last molars	8·00
„ „ „ of second premolars	6·20
Length of five molars	6·35
Length of last molar	1·60
Width of hinder barrel of last molar	1·54
„ fore „ „	1·70
Length of penultimate molar	1·50
Width of fore barrel of penultimate molar	1·65
Length of first molar	1·42
Width of fore barrel of first molar	1·70
Length of last premolar	1·00
Width of „ „	1·50

We may now compare the cranium of the new genus with the crania of the allied genera; the present cranium is distinguished from that of *Bramatherium* by the absence of the parietal pair of horn-cores, in consequence of which the crest of the occiput is simple and uninterrupted; instead of the convex profile of the cranium of *Bramatherium* the present cranium has a very markedly concave profile. The base of the horn-cores is widely separated from the orbits, and is as wide as the skull above the orbits; in *Bramatherium*, on the other hand, the base of the horn-cores is approximated to the orbits, and is constricted at its origin from the frontals; the occiput of *Hydaspitherium* is more quadrate and wider in proportion to its height than the occiput of *Bramatherium;* no figure of the basis cranii of the latter genus is given in Mr. Bettington's Memoir. The crania of both genera agree in having the supra-orbital horns arising from a common base—a character which is found in no other Ruminants. The form of the horn-cores of both the genera is unknown, though they were probably massive and branched like the posterior horns of *Sivatherium.* And here a question arises as to the homology of the horns of

the three allied genera. In his Memoir on *Bramatherium,* Mr. Bettington considers the frontal horns of that genus, which arise from a common base, to be homologous with the small and conical anterior horns of *Sivatherium,* which arise by a distinct base close above the orbits; according to this view the posterior horns of both genera will also be homologous. The position of the common base of the horns of *Hydaspitherium,* which is placed high up on the frontals, and only a short distance from the occipital crest, seems, however, clearly to show that these horns are homologous with the posterior horns of *Sivatherium;* and I think no one will doubt but that they are also homologous with the anterior horns of *Bramatherium,* which latter will then also be homologous with the posterior horns of *Sivatherium.* According to this view, the small anterior horns of *Sivatherium* have no representative in the other genera; and the posterior horns of *Bramatherium* are also unrepresented in the cranium of *Sivatherium;* the base of the horns of *Hydaspiötherium* is so large that I think it quite probable that higher up it may have divided into two pairs of horns, which would then be homologous with the two pairs of horns of *Bramatherium;* only in the one case the two pairs take origin from a common base, and in the other the anterior pair only take origin from a common base, while the posterior pair rise from distinct bases. The supraorbital horns of *Camelopardalis giraffa* are probably homologous with the posterior horns of *Sivatherium,* while the azygos mesial bony elevation on the frontals of the former genus is, although not a true horn, perhaps homologous with the anterior horns of *Sivatherium;* the two pairs of horns of *Tetraceros quadricornis* are respectively homologous with those of *Sivatherium; Helladotherium* has no horns. The accompanying diagram represents these relationships.

Homology of horns of Sivatheridæ and Camelopardalis.



Turning now to the skull of *Sivatherium,* we find very considerable structural differences between it and the skull of the present genus; the first striking difference is the absence of any anterior horns near the orbit in *Hydaspitherium;* next we may notice there is only a very short and shallow contraction above the orbits in the cranium of *Sivatherium,* while above this contraction the skull expands

enormously, the bases of the horn-cores being separated by a long interval from each other, and closely approximated to the orbits; in *Hydaspitherium*, on the other hand, the skull has a long and deep contraction above the orbit, and is not wider at the base of the horns, which have a common origin, than at the orbits, while the base of the horns is separated by a long interval from the orbit; the larger horns of *Sivatherium* were mainly directed outwards, while the direction of those of the new genus was probably at first nearly vertical; the nasals of the latter genus were longer and not arched or pointed like those of *Sivatherium*. Owing to the position of the posterior horns, the temporal fossa of *Sivatherium* forms a comparatively narrow slit not wider than the orbit, and completely overarched by the base of the horn; in the cranium of *Hydaspitherium*, on the other hand, the temporal fossa is very wide, and quite open above. On the palatal aspect the cranium of *Sivatherium* is wider in proportion to its length than is the cranium of *Hydaspitherium*, while the space enclosed by the zygomatic arch has its transverse diameter longer than its antero-posterior diameter, the reverse being the case in *Hydaspitherium*. The form of the basi-occipital and sphenoid is nearly the same in both genera, but the anterior tubercles of the former bone are relatively much larger in the new genus; the line of the molars is more curved in *Sivatherium;* the occiput is relatively wider in the latter genus, while the depression for the ligamentum nuchæ approaches nearer to the foramen magnum, and the temporal fossæ are seen as large slits on the occipital surface, while they scarcely show in *Hydaspitherium*.

In the following characters the three allied genera agree, *viz.*, the presence of horn-cores on the upper part of the frontal; the general form of the teeth, which are coated with a rugose enamel; the great width of the posterior half of the base of the cranium; the elongated and wedge-shaped basi-cranial axis; the presence of two pairs of tubercles on the basi-occipital, of which the hindmost are small; the form and position of the free border of the palatines, and the direction and position of the orbit; the approximate parallelism of the basi-cranial axis and the palate.

In the Memoir quoted above, Dr. Murie lays great stress on the form and relations of the nasals, as connecting *Sivatherium* with *Saiga;* this, on the face of it, appears to me a very insignificant character, and is also one which, as stated above, is not borne out by the present genus, in which the nasals are connected with the maxillæ; as showing the slight value of this character, I may refer to a new Turkestan sheep, *Ovis karelini* of Severtgoff,[1] in which the nasals do not articulate with either the maxillæ or premaxillæ, as in *Saiga*, and yet no one would think of classifying the two together: the unimportance of the character in the *Bovidæ* was also noticed in an earlier portion of the present Memoir. From the form of its posterior horns Dr. Murie argues with more probability that *Sivatherium* was also related to *Antilocapra;* he, however, to a great extent ignores its relation-

[1] Ann. Mag. Nat. Hist., Ser. 4, vol. xviii. p. 210.

ship to *Camelopardalis*, with which the other genera show very strong points of affinity. The molar teeth of all the fossil genera agree with those of *Camelopardalis* in general form and in the rugose character of the enamel; in all the genera the orbit is situated far below the plane of the frontals, which is a feature peculiar to the group; in all there is a vacuity between the lachrymal and the nasals, and there is no suborbital fossa on the lachrymal: in all the tympanic is compressed and non-bullate; while the tympanics of, I believe, all the antelopes are furnished with a large bulla. In all the four genera the basi-occipital has the same general form, and the posterior tubercles are similar; the anterior tubercles are, however, large in *Hydaspitherium*, whereas in *Camelopardalis* they are nearly obsolete; this large size of the anterior tubercles is a character found in most genera of Antelopes, though not in *Tetraceros;* the basi-occipital is, however, more square in the Antelopes, and the anterior tubercles diverge more posteriorly than in *Hydaspitherium.* In all the four genera the plane of the basi-cranial axis is single, and is nearly parallel with the plane of the palate, most nearly so in *Camelopardalis* and *Hydaspitherium,* and least so in *Sivatherium:* in all the antelopes the plane of this axis forms a large angle with that of the palate, and there is generally an angle at the junction of the basi-occipital and basi-sphenoid: in *Tetraceros* the plane of the basi-cranial axis forms a smaller angle with the plane of the palate than in other antelopes; in the oxen, sheep, and goats, the inclination of the two planes is the same as in the antelopes, whereas in the deer the plane of the basi-occipital is nearly parallel to that of the palate. In *Camelopardalis, Bramatherium,* and *Hydaspitherium,* the vertical diameter of the foramen magnum is larger than the transverse; in *Sivatherium* the two diameters are nearly equal, while in the antelopes the transverse diameter is the larger of the two.

The main points by which the fossil genera differ from *Camelopardalis* are the following: in the fossil genera the inferior border of the orbit is the most prominent of the two, while in the living genus the superior border is more prominent than the inferior border; the nasals articulate with both maxillæ and premaxillæ, and are relatively longer in the living genus; the form of the occiput of *Camelopardalis* is also very different, being narrow, with an overhanging crest, with no distinct fossa for the ligamentum nuchæ, and with narrow and distinct paroccipital processes.

In conclusion, I think it may be said that the affinities of the new genus are much closer to *Camelopardalis* than to any other living form; and that, together with *Bramatherium,* this new genus forms a link between *Camelopardalis* and *Sivatherium,* the latter having certain points of affinity to the antelopes.

The teeth of *Vishnutherium iravadicum*[1] of which only those of the lower jaw are known, are of too small a size to have belonged to this genus; they are further distinguished by the sculpturing on the enamel being more distinct.

[1] Teeth and Other Remains of Mammalia, p. 37—55, pl. 7, figs 1 & 2.

Family,—CAPRIDÆ.

Genus: CAPRA.

Of this division of the Ruminantia, the number of forms hitherto discovered in the Indian Tertiaries is very small, and individual specimens are also rare. One species of *Capra* I have determined from the cast of a cranium, the original of which is in the British Museum, and which was collected in the Siwaliks of the Markanda river by Dr. Falconer; a second species is founded on a portion of cranium with horn-cores from Perim Island, now in the Indian Museum; while a third form, to which I have not assigned a specific name, is only known to us from several portions of detached horn-cores, collected by Mr. Theobald in the Upper Siwaliks of the Potwar district; this last form was allied to, though distinct from, the existing Himalayan Markhoor, *Capra falconeri.* The late Mr. Blyth[1] announced the discovery of a part of the cranium and horn-cores of an ibex from the Siwaliks in the following words: "I have received a portion of a head and horn-cores of a true ibex, to all appearance identical with the species (*Capra sakeen,* nobis) which still inhabits the loftiest Himalayan crags." I am unable to discover what has become of this specimen, but I very much doubt if it is specifically identical with *Capra sibirica* (*C. sakeen,* Blyth). Mr. Blyth then proceeds to say that the occurrence of this fossil proved the existence of lofty mountains close to the old Siwalik area; this supposition is confirmed by the discovery of the above-mentioned horn-core of a goat allied to the Markhoor in the Potwar district.

No species of the genus *Capra* is included by Dr. Falconer in any of his Lists of Mammals from the Indian Tertiaries, though the above-mentioned cranium from the Siwaliks appears to have been referred by him to this genus. The addition of this genus to the Fauna of the Indian Pliocene strata, is extremely important, as it is one of the most modern forms of the modern group of Ruminants; all the European fossil species belong to the "diluvial" or post-tertiary epoch, and its occurrence in India with *Chalicotherium* and other extinct forms leading back to the Miocene period is only another instance of the strange mixture of genera which we find in these strata. The species described below from Perim Island seems undoubtedly to have been obtained from the same beds in which the jaws and teeth of *Dinotherium* and *Acerotherium* were found!

Capra Sivalensis, n. sp. *nobis.* Pl. 28, figs. 1 & 2.

Of this species we have several detached horn-cores in the Indian Museum, but I have figured the cast of a specimen of the cranium now in the British Museum, which is more complete than any of our own. The specimen figured exhibits the posterior half of the cranium above the orbits, with the horn-cores of both sides.

[1] Ann. Mag. Nat. Hist., ser. 1, Vol. XI, p. 78.

The parietals are of considerable length; between the horn-cores and the occiput they are rounded superiorly and excavated laterally by the temporal fossæ; the occipital surface forms an obtuse angle with the plane of the parietals, and its transverse diameter is greater than its vertical diameter; the basioccipital is obscured by matrix; the orbit is situated immediately below the horn-cores, and the two are separated by a considerable interval. There is a small supra-orbital foramen, but no sinus; the horn-cores are placed very closely together at their base, and curve upwards and backwards, with an extremely slight outward direction: they diminish very rapidly in width, and their antero-posterior diameter is very much greater than their transverse diameter; their cross-section is somewhat triangular, presenting sharp ridges at their two internal angles, and a third ridge at the hinder half of their outer surfaces. The measurements of the specimen are as follows:—

	Inches.
Length from anterior border of horn-core to occiput	4·85
Interval between horn-core and orbit	2·00
Breadth of cranium at orbits	4·20
Width of occiput	3·25
Height of „	2·00
Length of anterior border of horn-core	7·20
Transverse diameter of „	1·55
Antero-posterior diameter of „	2·75
Interval between bases of horn-cores	0·40

The cranium of this species is distinguished from the crania of the small-horned females of *Capra sibirica,* and *Capra ægagros* by the horn-cores being so much more closely approximated at their bases, by their being very slightly inclined outwards, and by their thickness at the base.

Among the living goats the cranium of this species approaches nearest to that of *Hemitragus hylocrinus* of the Nilghiris; the horn-cores of both species have nearly the same position and direction; those of the living species, however, are placed slightly wider apart at their bases, form a rather more open curve, and have a nearly flat surface in front: the distance also between the horn-core and the orbit is somewhat less than in the fossil species, and the parietals are flatter and less rounded superiorly. It is, however, quite possible that the recent and fossil forms should be placed in the same genus.

Capra perimensis, n. sp. *nobis.* Pl. 28, fig. 4.

The specimen on which this species is founded is from the collection of the Asiatic Society of Bengal; it was obtained from Perim Island by Captain Fulljames, and was entered in the Catalogue of the Society's Collection (No. $\frac{P.\ I.}{50}$) as the cranium of a species of antelope by Dr. Falconer; to this genus it cannot belong, as is at once shown by the form of the horn-cores, which have a keel on both anterior and posterior borders, and a very long antero-posterior diameter, conditions which are found in no antelopes, and which are characteristic of the goats.

The specimen comprises a portion of the frontals and parietals, with the nearly complete horn-cores of both sides; the portions of the frontals remaining are convex

below the horn-cores, and concave between the horn-cores; the parietals are rounded; the orbit is approximated to the base of the horn-core. The bases of the horn-cores are separated by a considerable interval; the direction of the horn-cores is upwards, outwards, and slightly backwards; they are straight, and decrease in diameter very gradually from base to summit; their antero-posterior diamcter is much greater than their transverse diameter; there is a sharp keel at their anterior and posterior borders; the anterior has a very slight twist from within outwards. The dimensions of the specimen are as follows:—

	Inches.
Interval between base of horn-core and orbit	1·1
Width of cranium across the orbits	4·9
Interval between bases of horn-cores	1·6
„ „ summits of „	6·5
Length of left horn-core	5·8
Antero-posterior diameter of base of horn-core	2·6
Transverse „ „ „	1·8

From the cranium of the last species, and from the crania of any of the living Indian goats, the present specimen is distinguished by the wide interval which separates the bases of the horn-cores, and by their direction and the marked keel on their anterior border.

Of thc crania of living goats, that which has the nearest approach to the present specimen is the cranium of the European *Ægoceros pyrenaicus;* the horn-cores of both forms agrce in being widely separated at the base and approximated to the orbit. Those of the European species, howevcr, are distinguishcd by being longer and more slender than those of thc present specimen. (Figures of the crania of the European species will be found in Nouv. Mem. Soc. Hel. 1838.)

Capra, sp. Pl. 28, fig. 3.

The specimen in the above figure is a fragment of a horn-core of the left side of a species of goat; it was collected by Mr. Theobald in the Siwaliks of the Potwar district. The specimen has a large antero-posterior diameter, and a small transverse diameter; the lateral surfaces are flattened, and the anterior and posterior borders are sharply keeled; the horn-core is twisted on its longitudinal axis, so that the anterior keel curves from within outwards, as in the existing Markhoor. The dimensions of the specimen are as follows:—

	Inches.
Length of fragment	5·8
Anterior-posterior diameter of base	2·3
„ „ „ summit	1·5
Transverse „ base	1·4

This horn-core doubtless belonged to a species of goat closely allied to the Markhoor (*Capra falconeri*); but it is distinguished from the horn-cores of that species by having a sharp keel on its anterior border, whereas the corresponding border of the horn-core of the Markhoor is rounded. More complete specimens are required before we can fully point out the affinities of this specimen.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SUPPLEMENT TO CRANIA OF RUMINANTS,

By R. LYDEKKER, B.A.,

GEOLOGICAL SURVEY OF INDIA.

(WITH SUPPLEMENTAL PLATES XXIA AND B, XXIIIA, AND REISSUE OF PLATES XXI AND XXIV).

The addition of several skulls of Siwalik antilopoid Bovidæ to the collection of the Indian Museum, and the publication of an important memoir on Tertiary Ruminants by Professor Rütimeyer,[1] have shown me that in the "Crania of Ruminants" my identifications of the specimens in the Indian Museum with the genera *Hemibos* and *Amphibos* of Falconer were generally erroneous, and also that the new genus *Peribos* cannot stand. The first part of Professor Rütimeyer's memoir was published previously to my own, but unfortunately had not reached India at the time of publication of the latter; the second part was published later than my own memoir, of which it contains a review, and points out the errors into which I had fallen. In my memoir I referred to the extreme difficulty of recognizing Falconer's species of Bovidæ merely from the figures in the supplemental plates of the "Fauna Antiqua Sivalensis," without access to the original specimens, and I at one time thought of discarding Falconer's names and applying new ones of my own. The identification of Falconer's species from the original specimens in the British Museum by Professor Rütimeyer has now rendered these species distinctly identifiable, and I, therefore, must now alter the names of my wrongly identified species. I, however, for reasons given below, do not adopt the names assigned by Professor Rütimeyer. I have reissued descriptions of the plates of the wrongly identified skulls, with their new names, as well as those under which they were first described.

[1] "Die Rinder der Tertiär Epoche, etc." Abhandlungen der Schweizerischen paläntologischen Gesellschaft, Vols. IV and V. Basel, 1877-78.

Family—BOVIDÆ.

GENUS: BOS.

SPECIES: BOS PLANIFRONS & BOS ACUTIFRONS, Lyd. Plates XII, XIII, XVI, figs. 2, 4, pp. 109, 112.[1]

Professor Rütimeyer[2] considers that both these forms are closely related to, if not varieties of, the European *Bos primigenius,* and that they both belong to the same species, the differences in the form of the skulls and horn-cores being merely individual or sexual varieties. With regard to the latter hypothesis, I may mention that we have other imperfect frontlets of these forms in the Indian Museum, showing that the cranial characters of the figured specimens are constant. From the great differences in the form of the two skulls, already sufficiently pointed out in my descriptions, I cannot but adhere to my opinion that these two skulls belong to perfectly distinct species. I have already pointed out the resemblance of the skull of *B. planifrons* to that of *B. primigenius*; *Bos acutifrons,* on the other hand, appears to me to be so widely different in the form of its occiput, frontals and horn-cores from *B. primigenius,* that I cannot consider them even closely allied, much less as belonging to the same species. Professor Rütimeyer does not mention that both the Indian species are certainly not newer than the Pliocene, while the European species is of Pleistocene age.

BUBALUS PLATYCEROS, Lyd. PLATE XVIII, p. 127.

Synonym: *Bubalus sivalensis, Rüt.*

Professor Rütimeyer[3] mentions that *Bubalus platyceros* belongs to the same species as a cranium in the British Museum, which he has described and figured under the name of *Bubalus sivalensis.*[4] My own name was first applied to the species in 1877,[5] while Professor Rütimeyer's description did not appear till the following year, after my figure and full description were published; my name has, therefore, the right of priority. Even apart from this, since the name of *Bison sivalensis* has been applied to one of the Siwalik Bovidæ, it would not be desirable to have the same specific name for another species which by many naturalists would be included in the same genus.

[1] The references here given to the "Crania of Ruminants" refer to the volume paging.

[2] *loc. cit.,* p. 184.

[3] *Ibid.* p. 186.

[4] *Ibid.* Pl. II, figs. 4, 5, p. 138.

[5] Rec. Geol. Surv. India, Vol. X, p. 31.

Genus: HEMIBOS, *Falconer*.

(Including *Peribos* and *Amphibos*).

Plates XX to XXIV.

In his above-quoted memoir on Tertiary Ruminants, Professor Rütimeyer has pointed out [1] that my identifications of *Hemibos triquetriceros* and *Amphibos acuticornis* of Falconer are wrong, the skull which I have figured as belonging to the former species in Plates XXII and XXIII really belonging to the latter, and one of the skulls which I have referred to the latter (Plate XXIV) really belonging to the former. Professor Rütimeyer has also pointed out that the skull to which the specific name of *occipitalis* seems to have been applied by Falconer, and which I have figured under the name of *Peribos occipitalis* (Plates XX, XXI fig. 2) is also an aberrant form of *Hemibos triquetriceros* of Falconer. Additional skulls lately acquired by the Indian Museum, had in a great measure convinced me of my erroneous identifications previously to seeing Professor Rütimeyer's memoir. The new material at hand, with Professor Rütimeyer's memoir, appears to me to warrant the union of the genera *Hemibos* and *Amphibos* (and of course *Peribos*)[2]. Under the former names I formerly took the form of the horn-cores as affording grounds for these generic distinctions, but now find that these characters are insufficient.

Species I: Hemibos occipitalis, Falc. *sp.* Plates XX, XXI, fig. 2, XXI A, XXIV.

Synonyms: *Hemibos triquetriceros*, Falconer.
Leptobos trequetricornis, Falc. Mss.
Bos occipitalis, Falc. Mss.
Probubalus triquetricornis, Rütimeyer.
Peribos occipitalis, Lydekker (olim).
Amphibos acuticornis, Lyd. (olim).

The skull figured in Plate XX [3] of this volume is so different from the skulls of *Hemibos triquetriceros*, figured by Falconer, that with the material formerly at hand I was quite unable to identify it with that species, and accordingly adopted the specific name of *occipitalis* apparently proposed for the figured specimen by Falconer, with the new affix of *Peribos*. In the supplemental Plate XXIA I have had drawn another skull lately presented to the Indian Museum by the Roorkee (Rúrki) Museum, which evidently belongs to the same species as the skull drawn in Plate XX. The

[1] loc. cit, pp. 186-187.

[2] From a manuscript of Falconer's lately shown me by Mr. Davies in the British Museum (referred to at page 136 of Professor Rütimeyer's memoir), it appears that Falconer determined finally to unite the genera *Hemibos* and *Amphibos* under the common name of *Leptobos*, as we find in that MSS. the names *L. triquetricornis*, *L. acuticornis*, *L. antilopinus*, and *L. elatus*.

[3] I have had a reissue of the description of this and other plates issued, in which the specimens bear their new names, as well as those under which they are described in the text.

new skull, however, has the horn-cores less pyriform in cross-section than those of the other specimen, and with a less forward inclination. The form of the facial part of this skull also shows that it is identical with *Hemibos triquetriceros* of Falconer (F.A.S. Plate H., figs. 1, 3), and also that the skull which I have figured in Plate XXIV as *Amphibos* belongs to the same species. The horn-cores of the Roorkee skull, and of the specimen figured in Plate XX, are, however, very different from those of *H. triquetriceros* as figured by Falconer, one of the forms of which (F.A.S., Plate H., fig. 2) has straight horn-cores with a most distinctly triangular cross-section, while in others the section is sub-circular (fig. 1).

In his memoir, Professor Rütimeyer has figured the upper part of a skull with horns (Plate 1, figs. 3, 4) which he names *Probubalus triquetricornis*, being the equivalent to *Hemibos triquetriceros* of Falconer, but calls it an abnormal or "trochoceros" [1] form of the species. This skull is similar to the skulls figured in Plates XX and XXI A of this volume except that the horn-cores are less closely approximated to the occiput than in the first specimen.

Of what he considers the normal male form of the species, Professor Rütimeyer has figured a skull (Plate VII, figs. 1, 2), wanting the greater part of the horn-cores; in that skull the horn-cores, instead of curving forwards, as in the trochoceros form, appear, as far as can be judged from the portion remaining, to have been straight, and to slope backwards from the plane of the forehead: the latter has a high frontal ridge, and the whole aspect of the skull is extremely bubaline: the cross-section of the horn-cores is sub-triangular.

Two other specimens of the skull of the normal male form are figured in figs. 1 and 3 of Plate H of the "Fauna Antiqua Sivalensis," the latter being copied in Professor Rütimeyer's memoir (Plate IV, fig. 1). The horn-cores in the former of these specimens appear to present a sub-circular cross-section. The skull represented in Plate XXIV of this volume appears to belong to the normal form of the male.

In the skull drawn in fig. 2 of Plate H of the "Fauna Antiqua Sivalensis," the horn-cores have a most distinct triangular cross-section (noticed in the description of the plate as being characteristic), and a marked angle on their frontal aspect. The horn-cores of this specimen are extremely different from those of the trochoceros-form (Plates XX, XXIA), in which the cross-section is distinctly pyriform, and the anterior aspect presents no trace of an angle. From this great difference, I had at first, till I saw intermediate specimens, no idea that the skull which I called *Peribos occipitalis* could be *Hemibos triquetriceros;* the latter specific name being utterly inapplicable to it, except on the *lucus a non lucendo* principle. It indeed appears that the distinctly triangular form of the horn-cores of this species is an exceptional, in place of a normal character, there being only the one skull of Falconer's with this character well marked: further the horn-cores of *Amphibos acuticornis* of Falconer are very frequently most distinctly triangular (the cause of my errors of identification), and I have therefore come to the conclusion that the

[1] Curved-horned.

name *triquetriceros*[1] is extremely misleading and totally inapplicable to the species: I therefore propose to apply to the species the name of "*occipitalis*," originally applied by Falconer to the trochoceros form (Plate XX), and which in a wider sense may apply to all forms of the species.

Professor Rütimeyer has changed the generic name from *Hemibos* to *Probubalus*, of which I do not see the advantage; I propose accordingly that the species be known as *Hemibos occipitalis*, my generic term *Peribos* being dropped.

Professor Rütimeyer has pointed out the great resemblance of the normal form of this species to the buffaloes, the species being doubtless a connecting link between that group and the antelopes. The same author also includes in his genus the living *Anoa depressicornis* of Celebes under the name of *Probubalus celebensis;* the resemblance of the normal skulls of *Hemibos* (*Probubalus*) *occipitalis* with the skull of *Anoa* is certainly very close; in the earlier part of this work I pointed out the resemblance of *Anoa* to *Amphibos acuticornis* of Falconer, which I now include under the present genus. If Professor Rütimeyer is right in this generic identification, it appears to me that it would have been simpler to have included both the recent and fossil forms under the genus *Anoa*, and not to have given the living representative a new generic and specific name.

In Plate 1, fig. 1, of his memoir, Professor Rütimeyer has copied from fig. 4 of Plate H of the "Fauna Antiqua Sivalensis" another skull of *Hemibos occipitalis*, which he regards as the female form, and which is distinguished by its small cylindrical horn-cores.

Professor Rütimeyer has also figured and described[2] a hornless form of the species, from a skull in the British Museum.

In the text the description of the skull figured in Plate XX given on page 141 must be taken as that of the trochoceros male form of *H. occipitalis*, while that of the skull figured in Plate XXIV, and described on page 150, must be taken as that of the normal male of the same species.

SPECIES 2: HEMIBOS ACUTICORNIS, Falc. *sp.* Plates XXI, fig. 1, XXI B, XXII, XXIII, XXIIIA.

Synonyms: *Amphibos acuticornis*, Falc. and Rüt.
Leptobos acuticornis, Falc. MSS.
Hemibos triquetriceros, Lyd. (olim).

The cranium figured in Plates XXII and XXIII of this volume and described under the name of *Hemibos triquetriceros*, has straight horn-cores, with a most remarkable triangular cross-section, which are set upon a high frontal ridge. This

[1] The word *triquetriceros* is a barbarism (*triqueter* and κέρας), and Professor Rütimeyer has accordingly altered it to *triquetricornis*. It was written *triquetriceras* by Falconer, which I altered to *ceros*, like *Rhinoceros;* Mr. Blanford in the "Manual of Indian Geology" has altered the word to *triquetricerus*. In the above-quoted MSS. in the British Museum Falconer has altered the name to *triquetricornis*.

[2] *loc. cit.*, p. 132, Plate II, figs. 1 to 3.

cranium was thus named because of the remarkable resemblance of its horn-cores to the skull figured under the name of *H. triquetriceros* in fig. 2 of Plate H of the "Fauna Antiqua Sivalensis," in describing which the notes of Dr. Falconer[1] mention "the remarkable triangular form of the horn-core," and also because in describing the frontlet of *Amphibos acuticornis*,[2] it is stated that "the horns are rounded on their anterior surface and flattened behind." On these grounds I thought that the specimen in question must belong to *Hemibos triquetriceros* of Falconer, and the specimen figured in Plate XXIV with horns rounded in front, to *Amphibos acuticornis.* As, however, the latter specimen is now shown to belong to *Hemibos occipitalis* (*triquetriceros*), in which the horn-cores are not generally triangular in section, the skull drawn in Plate XXII must either belong to *Amphibos acuticornis* of Falconer or to a new species. None of the skulls figured under the latter name by Falconer[3] have a distinctly triangular cross-section, but in a specimen figured by Professor Rütimeyer,[4] the horn-cores are perfectly triangular in cross-section, and the skull (of which a side view is given) evidently belongs to the same species as my specimen (Plate XXII). Another skull recently acquired by the Indian Museum (Plate XXIIIA) has the anterior angle less distinctly marked than in my first specimen, and is in this respect intermediate between the latter and Falconer's large male skull;[5] the section of the horn-core in the new skull is, however, most markedly triangular. The horn-cores in the skulls figured by myself are also directed more upwards than are those of Falconer's type specimen, but these differences, with the help of intermediate forms, do not appear to be more than individual varieties, and I therefore come to the conclusion that the specimens referred to belong to *Amphibos acuticornis* of Falconer.

Since we have found that both in *Hemibos occipitalis*[6] and in *Amphibos acuticornis* of Falconer some forms have horn-cores with a triangular cross-section, and since the two are in other respects most closely allied, I now come to the conclusion that they cannot be generically or sub-generically distinguished, and I therefore propose to call the latter species *Hemibos acuticornis.*

The triangular-horned variety of *Hemibos acuticornis* (Plates XXII, XXIII, XXIII A) is distinguished from the triangular-horned variety of *H. occipitalis* by its somewhat narrower forehead and less telescopic orbits, as well as by the more upright direction of the horn-cores: it presents no close resemblance to the trochoceros form of the latter species.

All the skulls of *H. acuticornis* hitherto referred to, are evidently those of males, the specimen figured in Plate XXII being evidently that of an old individual with the sutures obliterated. Another skull has, however, been figured by Rütimeyer[7] and Falconer and Cautley,[8] which is referred by the former to the female;

[1] Description of Plates of F. A. S.
[2] F. A. S., Plate I, (lettered series), fig. 2.
[3] F. A. S., Plate I. (lettered series).
[4] *loc. cit.*, Plate III, fig. 7.
[5] F. A. S., Plate I, fig. 2.
[6] F. A. S., Plate H, fig. 2.
[7] *loc. cit.*, Plate III, figs. 4 & 5.
[8] F. A. S., Plate I, figs. 3 to 6.

the horn-cores are small and sub-cylindrical, the orbits not prominent, and there is not the high frontal ridge so characteristic of the skull of the male (Plate XXIII). The cranium, of which a profile view is given in Plate XXI, fig. 1, and a front view in Plate XXIB of this volume, agrees very closely with the above-mentioned skull, and belongs probably to a young female of the same species. The description of the skull given on pages 145 to 148 of this volume must be taken as that of the male skull of this species; the female skull drawn in Plate XXI, fig. 1, and Plate XXIB is not fully described.

Species III: Hemibos antilopinus, Falc. *sp.* MSS.

Synonyms: *Probubalus antelopinus*, Rüt.
Amphibos antilopinus, Falc. MSS.
Leptobos antilopinus, Falc. MSS.

On page 89 of this volume, I mentioned that I had no means of identifying *Amphibos antilopinus* of Falconer, and therefore abandoned the name. Among the Siwalik fossils in the British Museum, Professor Rütimeyer has, however, found a skull of a bovoid ruminant, which he says[1] seems to be that of *Amphibos* or (*Leptobos*) *antilopinus*[2] of Falconer, and which he has figured in his memoir[3] under the name of *Probubalus antelopinus.* Professor Rütimeyer also mentions that he is not certain whether the skull be that of a male or female individual. The horn-cores are subpyriform in cross-section, thereby approaching to those of the trochoceros male of *Hemibos occipitalis,* and the orbits prominent, which is also a character of the latter species as opposed to *H. acuticornis.* It is worthy of note, as indicating the generic identity of all these animals, that whereas *H. antilopinus* was placed at first by Falconer in his genus *Amphibos,* it is placed by Rütimeyer in *Hemibos* (*Probubalus*).

Genus: LEPTOBOS, Falc. MSS.

Species: Leptobos falconeri, Rütimeyer.

Synonyms? Amphibos elatus, Falc. MSS.
„ *? Leptobos elatus*, Falc. MSS.

Professor Rütimeyer has described and figured[4] several skulls of another bovoid ruminant in the Siwalik collection of the British Museum, under the name of *Leptobos falconeri,* mentioning that it is very possible that these skulls belong to *Amphibos* (*Leptobos*) *elatus* of Falconer. Three of these skulls are drawn without any name, in the unfinished Plate S of the supplement to the "Fauna Antiqua Siva-

[1] *Loc. cit.*, p. 136.
[2] The name is spelt *antelopinus* by Professor Rütimeyer.
[3] Plate I, figs. 5, 6.
[4] *loc. cit.*, p. 157, Plate I, figs. 7, 8; Plate IV, figs. 3, 4, 5, 6; Plate VI, fig. 9.

lensis." Of this species there was a horned and a hornless form, the latter, in my opinion, being probably the female. The horn-cores are sub-cylindrical, and are placed very far apart at their bases; the frontals are large and concave, and there is a distinct triangular parietal on either side. The general shape of the skull, when viewed from above, is sub-triangular, owing to the great expansion of the temporal regions, and consequently quite different from that of other *Bovidæ*.

Although it is probable that Falconer intended to class this species finally in the same genus with the three preceding forms, it appears to me that Professor Rutimeyer is quite right in placing it in a distinct genus or sub-genus.

Species 2 : Leptobos (Bibos ?) frazeri, Rüt.

This species is named by Professor Rütimeyer [1] on the evidence of a single imperfect hornless cranium of a bovoid ruminant, said to have been obtained by the British Museum from a collection made by Captain Frazer in the Narbada valley. There are two small crania from the same district in the Indian Museum, having a very close resemblance to the cranium figured by Professor Rütimeyer: these crania have small horn-cores.

Family—SIVATHERIDÆ.

Genus: BRAMATHERIUM, Falconer.

Species: Bramatherium perimense, Falconer.

On page 160 of this volume I referred to a cranium of a Sivatheroid, which I considered to be that of *Bramatherium perimense*. During a recent visit to London I found that the specimen in question is now in the collection of the Royal College of Surgeons, where it bears the above name.

Genus: HYDASPITHERIUM, Lyd.

Species: Hydaspitherium grande, and H. leptognathus, Lyd.

Since the publication of the "Crania of Ruminants," some jaws of *Hydaspitherium* have been noticed by myself [2]; one of these, *H. grande*, is a stout-jawed, and the other, *H. leptognathus* a slender-jawed form.

[1] *loc. cit.*, p. 165, Plate VII, figs. 11, 12.
[2] Rec. Geol. Surv. India, Vol. XI, p. 90.

Family,—CAPRIDÆ.

GENUS: BUCAPRA, Rüt.

SPECIES: BUCAPRA DAVIESII, Rüt.

Professor Rütimeyer[1] has described under the above name a very peculiar skull in the Siwalik collection of the British Museum. The skull is hornless and remarkable for the shortness of the face.

LIST OF INDIAN TERTIARY RUMINANTS.

The above corrections and additions render it necessary to re-write the list of Indian Ruminants given on page 92 of this volume.

PECORA.

BOVIDÆ	1. *Bos namadicus*, F. and C.	Narbada.
	2. *Bos planifrons*, Lyd.	Siwalik.
	3. *Bos acutifrons*, Lyd.	Ditto.
	4. *Bos platyrhinus*, Lyd.	Ditto.
	5. *Bubalus platyceros*, Lyd. (*B. sivalensis*, Rüt.)	Ditto.
	6. *Bubalus palæindicus*, F. and C.	Narbada and Upper Siwalik.
	7. *Bison sivalensis*, Falc. and Lyd.	Siwalik.
	8. *Hemibos occipitalis*, Falc., sp. *Hemibos triquetriceros*, Falc. *Probubalus triquetricornis*, Rüt. *Leptobos triquetricornis*, Falc. MSS. *Bos occipitalis*, Falc. MSS. *Peribos occipitalis*, Lyd. (olim). *Amphibos acuticornis*, Lyd. (olim).	Ditto.
	9. *Hemibos acuticornis*, Falc., sp. *Amphibos acuticornis*, Falc. and Rüt. *Leptobos acuticornis*, Falc. MSS. *Hemibos triquetriceros*, Lyd. (olim).	Ditto.
	10. *Hemibos antilopinus*, Falc., sp. *Amphibos antilopinus*, Falc. MSS. *Leptobos antilopinus*, Falc. MSS. *Probubalus antelopinus*, Rüt.	Ditto.
	11. *Leptobos falconeri*, Rüt. ? *Leptobos elatus*, Falc. MSS. ? *Amphibos elatus*, Falc. MSS.	Ditto.
	12. *Leptobos frazeri*, Rüt. *Bibos (?) frazeri*, Rüt.	Narbada.
ANTILOPIDÆ	13. *Antilope palæindica*, F. and C.	Siwalik.
	14. *Antilope patulicornis*, Lyd.	Ditto.
	15. *Antilope sivalensis*, Lyd.	Ditto.
	16. *Antilope porrecticornis*, Lyd.	Ditto.
	17. *Portax*, sp.,[2] Lyd.	Ditto.
	18. *Portax namadicus* (Rüt.[2])	Narbada.

[1] *loc. cit.*, p. 105, Plate II, figs. 6-9.
See Preface to volume.

SIVATHERIDÆ	19. *Sivatherium giganteum*, F. and C.	Siwalik.
	20. *Vishnutherium iravadicum*, Lyd.	Burma.
	21. *Bramatherium perimense*, Falc.	Siwalik.
	22. *Hydaspitherium megacephalum*, Lyd.	Ditto.
	23. *Hydaspitherium grande*, Lyd.	Ditto.
	24. *Hydaspitherium leptognathus*, Lyd.	Ditto.
CAMELOPARDALIDÆ	25. *Camelopardalis sivalensis*, Falc. and Lyd.	Ditto.
CAPRIDÆ	26. *Capra sivalensis*, Lyd.	Ditto.
	27. *Capra perimensis*, Lyd.	Perim.
	28. *Capra*, sp., Lyd.	Siwalik.
	29. *Bucapra daviesii*, Rüt.	Ditto.
OVIDÆ	30. *? Ovis*, sp., Blyth	Ditto.
CERVIDÆ	31. *Cervustriplidens*, Lyd.	Ditto.
	32. *Cervus simplicidens*, Lyd.	Ditto.
	33. *Cervus*, sp.	Narbada.
	34. *Dorcatherium minus*, Lyd.	Siwalik.
	35. *Dorcatherium majus*, Lyd.	Ditto.

TYLOPODA.

CAMELIDÆ	36. *Camelus sivalensis*, F. and C.	Siwalik.

For other unnamed species, see Preface to volume.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

SIWALIK AND NARBADA PROBOSCIDIA,

By R. LYDEKKER, B.A.,

GEOLOGICAL SURVEY OF INDIA.

[WITH PLATES XXIX TO XLVI].

Order—PROBOSCIDIA.

Family—DINOTHERIDÆ.

Proboscidia, in which the whole of the permanent dentition is in use at the same time, and in which the second true molar has one ridge less than the preceding tooth.

Dentition and affinities of the Dinotheridæ.

The molar dentition of *Dinotherium*, the only genus of the family, in its mode of succession, follows the normal mammalian plan; in the permanent dentition there are the full number of these teeth, while the premolars are reduced to two (penultimate and last), which have succeeded more complex milk-molars. Both premolars are two-ridged teeth like those of the Tapir; the penultimate milk-molar has two ridges, and the last three: the first true molar has three ridges, and the second and third have only two. In the equal number of ridges in the last milk-molar, and the first true molar, the genus agrees with the Mastodons, from which it is distinguished by the two last true molars having a smaller, in place of a larger, number of ridges, than the first.

In the one species in which the complete skull and lower jaw are known (*D. giganteum*), there are no incisors or canines in the upper jaw, but a single pair of large recurved incisors in the mandible. It is probable, from the form of the jaw, that similar incisors were developed in two Indian species, (*D. indicum, D. pentapotamiæ*), but not in a third (*D. sindiense*).

In the form of its cranium *Dinotherium* makes a curious approach to that of some of the Sirenia, especially *Halitherium*, but has also elephantine characters. The last milk-molar and the first true molar are like those of the Trilophodons, while the other true molars are like those of *Listriodon* (Ungulata): the premolars are like those of *Tapirus*. There is also some resemblance between the molars

of *Dinotherium* and those of *Uintatherium.* Marsupial bones are said to have been developed.[1] The genus may be considered as a generalized form connecting the Ungulata and Sirenia with the Proboscidia.

Genus : DINOTHERIUM, Kaup.

Molars with simple ridges and open valleys, and with not more than three ridges in any one tooth.

Species I: Dinotherium pentapotamiæ, Falconer, *et nobis.*

Pls. XXIX, XXX, and XXXI, fig. 3.

History.—In a previous fasciculus of the present volume of the "Palæontologia Indica,"[2] I have already figured and described certain molar teeth of a species of Indian *Dinotherium* under the name of *D. pentapotamiæ*,[3] and in the same notice I have given the history of the species. At the time of publication of that notice, the teeth figured and described were the only specimens belonging to *D. pentapotamiæ*, contained in the collection of the Indian Museum. Subsequent collections, made by Messrs. W. T. Blanford and Fedden in Sind, and by Mr. Theobald in the Punjab, have, however, greatly enriched the series of teeth of that species in the Indian Museum, and have rendered it necessary to add a second notice to my previous descriptions. The most important of these new specimens, together with two specimens of fragments of the mandible, which were transferred to the Indian Museum from the collection of the Asiatic Society of Bengal, are now figured and described in Plates XXIX to XXXI of this memoir. Of the two last mentioned specimens a short notice by myself has already appeared in the "Records of the Geological Survey of India."[4]

Mandible.—The specimen represented in fig. 1 of Pl. XXIX is one of the two specimens mentioned above, as having been transferred from the collection of the Asiatic Society of Bengal. It was found stowed away in an old box with a few other mammalian fossils, without any trace of label or ticket. That it came from the Siwaliks is, however, perfectly evident from the circumstance that the specimen is still covered in many places with a coating of the very characteristic grey Siwalik sandstone.

The fragment carries two molar teeth, the hindmost and least-worn of which

[1] Amer. Journ. Science and Art. Ser. II, vol. XXXVIII, p. 427.

[2] "Molar Teeth and other Remains of Mammalia," p. 72, (volume paging) Pl. IX,—figs. 1—5.

[3] It may, perhaps, be not out of place to give the etymology of the term *pentapotamiæ*, which might not be understood by the non-Indian reader. "Pentapotamia" is Falconer's Greek translation of the Punjab; the Indian word, as is well known, means the "country of the five rivers" (*Punj* or *Panch*, five, and *áb*, water or river); Pentapotamia is formed, like Mesopotamia, from πέντε (five) and πόταμος (river).

[4] Vol. X, p. 33.

is nearly perfect, while the other has been considerably chipped. The worn summits of the transverse ridges of the hinder molar (right side of figure) are lowest on the lower border of the figure; this border will consequently be the outer side of the specimen, which will, therefore, belong to the left ramus of the mandible.

Since the hinder molar exhibits no disc of pressure on its posterior surface, and since both teeth carry two main ridges only, it is evident that these two teeth are the two last of the permanent molar series, and that consequently the individual to which they belonged was fully adult at the time of its death. The anterior ridge of the hinder molar, which, as being the more perfect of the two teeth, is here selected for description, is concave anteriorly and nearly straight posteriorly; the plane of wear of both this and of the second ridge slopes towards the hinder extremity of the jaw; the second or hinder ridge is concave on the inner half of its anterior surface, and convex on the outer half; its posterior surface is nearly straight, with slight undulations. In the valley between the two main transverse ridges there is a projecting spur given off from the hinder ridge, passing obliquely inwards and forwards. In a later state of attrition than the specimen exhibits, as in the anterior molar (left side of figure), this intermediate longitudinal spur would display a worn dentine surface, which would ultimately form a narrow bridge of dentine connecting the dentine surfaces of the two transverse ridges. There is a small tubercle on the outer side of the main transverse valley. At the posterior extremity of each tooth there is a large talon-ridge, broader at its outer than at its inner extremity, and about half the width of the anterior main ridge; there is a slight trace of a cingulum on the outer surface of this talon, as is well seen in the anterior tooth; eventually the talon-ridge becomes worn down, and forms a part of the grinding surface of the tooth. Each tooth is implanted in the jaw by three distinct fangs; two small ones at the anterior extremity, and a larger and laterally compressed one at the posterior extremity.

The Indian Museum has obtained recently, through exchange with the Lahore Museum, two last lower molars of the same species of *Dinotherium*. These two teeth agree precisely in every detail with the figured specimen. They appear to have been obtained from the Siwaliks of Shaik Budín, on the north-west frontier of the Punjab. A similar specimen has also been presented to our collection by the Roorkee (Rúrki) Museum, which seems to have been obtained near Roorkee itself—very possibly low down in the Siwalik series, as it carries fragments of a red matrix like that of the Nahan (lower Siwalik) rocks.

The second specimen which I have figured (Plate XXIX, figs. 2 and 3) appears to have come from Siwalik beds at Kúshalghar, near Attock, where it was obtained many years ago by the late Lieutenant Garnet; these beds are probably somewhat older than the general mammaliferous zone of the Siwaliks and the representative of the Nahan rocks. As I have already observed in the above-quoted passage in the "Records," the figure of this specimen given by Dr. Murchison in the "Palæonto-

logical Memoirs,"[1] under the name of *Antoletherium* is entirely incorrect. It appears probable that Dr. Falconer never saw the original specimen, but made his new genus *Antoletherium* solely on the evidence of the imperfect drawing from which the figure was taken; a copy (or the original) of this drawing was sent by Dr. Falconer to Professor Owen, whose note on the subject will be found on page 416 of the first volume of the "Palæontological Memoirs."

This specimen contains portions of three molar teeth, all more or less damaged, but of which the central one is the most complete; the tooth on the left hand carries two transverse ridges, connected by a median antero-posterior bridge, and is fairly well represented in the figure in the "Palæontological Memoirs." The central tooth carries three ridges, of which the one on the right side of the figure is the narrowest, and is separated from the adjacent ridge by a transverse valley, which is narrower than the valley between the two ridges on the left side of the figure; antero-posterior ridges connect the three transverse ridges. In Dr. Falconer's engraved figure this central tooth (B) is erroneously represented, as having only two transverse ridges, its third ridge having been added to the broken tooth on the right side of the figure (C in Falconer's figure). The third tooth (on the right side of the figure), has a higher and larger crown than either of the others; unfortunately only a portion of its first ridge remains: the worn surface of this ridge slopes towards the right side of the figure, and the dentine surface is largest on the lower border of the figure.

From the evidence of the incomplete drawing sent by Dr. Falconer, Professor Owen remarks[2], "the tooth B (*central tooth*) is more worn than A (*left tooth in figure*) and A than C (*right tooth in figure*). B may therefore be molar 1, and C premolar 4, or the last premolar, A being the second true molar."

The relative conditions of wear of the three teeth are precisely as stated by Professor Owen, and the central three-ridged tooth is undoubtedly the first true molar: the position of the other two teeth in the molar series was, however, wrongly determined by Professor Owen. If we refer to De Blainville's or Kaup's[3] figures of the lower dentition of *Dinotherium*, we shall find, on looking at the first molar, and the two adjacent teeth, that the first molar is the most worn, the last premolar the next most worn, while the second true molar is the least worn of the three. In our specimen, therefore, the tooth on the left (*A of Professor Owen*) is the last premolar; the central tooth, as we have said, is the first true molar, while the broken tooth on the right (*C of Professor Owen*), is the second true molar. That this is really the case, irrespective of the state of wear of the teeth, is proved by the worn surface of the ridge of the right-hand tooth, sloping towards the right-hand of the figure, since in all species of *Dinotherium* the worn surface slopes towards the hinder extremity of the jaw. Again, the hindmost ridge and valley of the first lower molar

[1] Vol. I, Plate XXXIV, figs. 1-2.

[2] Pal. Mem. *loc. cit.*

[3] Blainville: "Osteographie des Mammifères," Atlas, *Dinotherium*, Pl. III :—Kaup. "Ossemens Fossiles de Darmstadt," Pl. I*a*.

of *Dinotherium*, are smaller and narrower than the two anterior ridges and the anterior valley, as is the case in our specimen; while, as a fourth proof, the right-hand tooth is the larger of the three, and must consequently be the last of the series. From the form of the worn dentine surface of the second true molar of our specimen, it is clear that the fragment belongs to the left ramus of the lower jaw; the right-hand tooth of this specimen, therefore, corresponds with the first ridge of the left-hand tooth (second true molar) of the specimen drawn in fig. 1 of the same plate.

Neither the last premolar nor the first true molar of this specimen carry any talon-ridges; the anterior extremity of the second true molar is likewise not furnished with any talon. The longitudinal bridge connecting the transverse ridges of the last premolar is higher than the similar bridge connecting the two anterior ridges of the first true molar; there is a large blunt tubercle placed on the outer side of the anterior valley of the last-named tooth.

Lower jaw from Sind.—The fine specimen of the greater portion of the lower jaw of a *Dinotherium* represented on Plate XXX, was obtained by Mr. W. T. Blanford from the Siwaliks (Manchars) of Sind in 1877, and has already been briefly noticed by me in the "Records."[1] The specimen comprises the middle portion of the left ramus of the mandible, and contains the last premolar and the three true molars, all in a very fine state of preservation. The two teeth on the left of the figure will correspond in serial position to the two complete teeth represented in fig. 3 of Plate XXIX (last premolar and first true molar), while the two teeth on the right correspond to the two teeth represented in fig. 1 of the same plate (second and third true molars).

The mandible is abruptly broken off at both extremities of the series of teeth; the middle of the specimen is, however, complete, so that the depth of the jaw can be ascertained. The enamel of the first ridge of the last true molar is only slightly perforated by wear; from which we may conclude that the animal to which the jaw belonged had only just attained its maturity at the time of its death.

Last premolar.—The last premolar is a simple two-ridged tooth, distinguished from the corresponding tooth in the European *Dinotheria* by the absence of the large anterior talon, which always occurs in the European forms. A low longitudinal bridge connects the two transverse ridges of this tooth; owing, however, to the incapacity of the native artist who drew this specimen, this longitudinal bridge is not distinctly apparent in the figure: this bridge is not so high as the one in the homologous tooth represented in fig. 3 of the preceding plate, but if the tooth were still more worn down, the dentine of this longitudinal bridge would be exposed, and would then connect by an isthmus the dentine surfaces of the fore-and-aft transverse ridges, which at present form islands; this connection would not, however, take place so soon as in the homologous tooth of the other specimen.

First true molar.—The first true molar is of the same width as the last premolar; and, as is always the case, this tooth carries three transverse ridges; the exposed dentine surfaces of the two anterior transverse ridges are connected by an

[1] Vol. XI, p. 75.

isthmus of dentine, formed by the abrasion of a mesial longitudinal bridge. We have already seen that a similar condition occurs in the homologous tooth of the jaw represented in fig. 3 of Plate XXIX. The valley between the second and third transverse ridges is still open, and these two ridges would not be connected by an isthmus of dentine until the tooth was much more worn down than at present.

Second & Third true molars.—The two last molars in the Sind jaw are considerably wider than either of the preceding teeth: the penultimate tooth carries two transverse ridges, and has only a very slight trace of a posterior talon; in the latter respect it differs from the homologous tooth of the jaw represented in fig. 1 of Plate XXIX : it also differs from that tooth in having merely a very slight trace of a longitudinal bridge, and consequently, although the two teeth are in almost exactly the same state of wear, exhibits no worn dentine surface projecting from the hinder ridge into the transverse valley.

Third true molar.—The last or third true molar (right side of figure), also carries two transverse ridges, and has a large three-cornered posterior talon, and a low longitudinal bridge projecting from the second ridge into the transverse valley. In all its characters, this tooth agrees precisely with the homologous tooth in the jaw represented in fig. 1 of Plate XXIX, and, therefore, needs no further description.

Dimensions of lower jaws.—In the following table the dimensions of the three lower jaws of *Dinotherium* described above are compared together. The dimensions in the first column of that table (*a*) are those of the specimen represented in Plate XXX; those in the second column (*b*) are the dimensions of the specimen represented in figs. 2 and 3 of Plate XXIX; while the dimensions given in the third column (*c*) are those of the specimen represented in fig. 1 of the latter plate.

	a	*b*	*c*
Length of four last teeth	9·3	...	...
Ditto last premolar	1·8	2·1	...
Width of ditto	1·74	2·05	...
Length of first true molar	2·34	2·4	...
Width of ditto	1·8	2·1	...
Length of penultimate true molar	2·4	...	2·9
Width of ditto ditto	2·15	...	2·15
Length of last true molar	2·9	...	3·18
Width of ditto	2·25	...	2·45
Depth of jaw at penultimate true molar	5·4	...	...
Thickness of ditto at ditto	3·4	...	...
Ditto of enamel of first true molar	0·1	0·1	...
Ditto ditto second ditto	0·15	...	0·16

Comparisons.—If we compare the dimensions of the first lower true molar of the specimen represented in fig. 3 of Plate XXIX with the dimensions of the homologous upper tooth of *Dinotherium pentapotamiæ*, figured and described in a previous fasciculus of this volume,[1] we shall find that the length of the latter tooth is

[1] "Molar Teeth and other Remains of Mammalia," pp. 56-74, Plate IX, fig. 2.

2·75 inches, and its greatest width 2·4 inches. As far, therefore, as the matter of size goes, the two specimens may certainly be referred to the same species, because in *D. giganteum* the upper molars are considerably larger than the lower. The ridges of the upper molar are more curved than those of the lower, but that is always the case in the teeth of this genus. The upper molar has not the connecting longitudinal bridges which are found in the lower molar, but this, as we shall subsequently see, appears to be a variable character, and I think we may therefore safely say that the specimen represented in Plate XXIX, fig. 3, belongs to *D. pentapotamiæ*.

Now, with regard to the other two specimens: if we take the last tooth of the specimen represented in fig. 1 of Plate XXIX and compare it with the homologous tooth of the specimen represented in Plate XXX, we shall, I think, certainly arrive at the conclusion that both these teeth belong to one and the same species; the only difference between them being that the latter tooth is very slightly the larger of the two.

The penultimate molars of the two jaws are distinguished, as we have already seen, by the presence of a hind talon, and an imperfect longitudinal ridge in the transverse valley of the one, and by their absence in the other. In consequence of the absence of this talon in the specimen represented in Plate XXX, this tooth is half-an-inch shorter than the homologous tooth in the other specimen; both, however, have precisely the same width. The complete absence of the hind talon in the one tooth may not improbably be explained by a greater pressure exerted on it by the succeeding tooth; the longitudinal bridge, as I have already said, I do not consider to be a character of much specific value; and I think that we may say that the lower jaws represented in Plate XXX and in fig. 1 of Plate XXIX belong to the same species; it therefore only remains for us to see whether they belong to the same species as the specimen represented in fig. 3 of the latter plate, or, in other words, to *D. pentapotamiæ*, to which I have referred that specimen.

On referring to the measurements of the three specimens given in the table above, it will be seen that the last premolar and the first true molar of the specimen represented in Plate XXX are slightly smaller than the homologous teeth of the specimen represented in fig. 3 of Plate XXIX; it will, moreover, be observed from the figures, that there is a slight difference in the relative development of the longitudinal bridges in the teeth of the two specimens. Beyond this difference in the development of the longitudinal bridge, and the slight difference in size, I can find no points of distinction between the teeth of the two specimens. With regard to the development of the longitudinal bridge, we have already seen that it varies in the two specimens of the two last molars represented in the accompanying plates, which certainly belong to the same species, and if we refer to the figures of the molars of *Dinotherium giganteum* given in the third volume of the atlas of De Blainville's "Osteographie," or in Kaup's memoirs, we shall find that in the specimens marked *D. cuvieri* and *D. intermedium* (these pseudo-species being

now considered merely as varieties of *D. giganteum*) the longitudinal bridge is much more developed than in the other specimens. In a large collection of the molars of *D. giganteum* from Eppelsheim, in the Indian Museum, I also find that there is a very great variety in the relative development of this bridge. It seems therefore that, as far as regards this longitudinal bridge, no valid grounds for specific distinction can be adduced.

There now remains, therefore, merely the question of the difference of size, and this is so slight that it may well be due to sexual difference only : I have, therefore, no hesitation in referring all the three specimens in question to *D. pentapotamiæ*.

Comparison with D. indicum and D. giganteum.—It now remains to compare these lower jaws with those of the other two well-established species of *Dinotherium*, namely, the Indian *D. indicum* and the European *D. giganteum*. The remains of the first of these species were originally obtained from Perim Island, and consisted of a broken molar and a portion of the mandible, which are described in the "Palæontological Memoirs.[1] Specimens of the teeth of this second Indian species, which was slightly larger than *D. giganteum*, are described in the sequel of the present fasciculus, where the characters which distinguish them from the corresponding teeth of *D. pentapotamiæ* will be found pointed at. Here it will be only necessary to compare together the dimensions of the three jaws of the last named species with the corresponding dimensions of the jaws of *D. indicum* and *D. giganteum* ; the dimensions of the two latter species are nearly all taken from the table given by Dr. Falconer in his above-quoted notice.[2] The three jaws of *D. pentapotamiæ* are respectively indicated by the same letters as were used in the table given on page 187 of this memoir.

	D. pentapotamiæ.			*D. indicum.*	*D. giganteum.*
	a	*b*	*c*		
Length of last premolar	1·8	2·1	...	2·9	3·3
Width of ditto	1·74	2·05	...	2·6	2·7
Length of first true molar	2·34	2·4	...	4·0	3·6
Width of ditto	1·8	2·1	...	2·8	3·0
Length of second true molar	2·4	...	2·9	3 9	3·3
Width of ditto	2·15	...	2·15	3·5	2·9
Length of third true molar	2·9	...	3·18	...	3·8
Width of ditto	2·25	...	2 45	...	3·5
Depth of jaw at second premolar	...	...	...	9·2	6·9
Ditto at first true molar	5·2	...	...	8 7	6·2
Ditto at second true molar	5·4	...	...	...	6·6
Ditto at third true molar	5 8	...	...	...	6·4
Width of jaw at second premolar	3·0	...	...	5·1	4·0
Ditto at first true molar	3·4	...	...	6·4	5·0
Ditto at second true molar	3·4	...	...	...	5·5
Ditto at third true molar	4·1	...	...	...	6·1

[1] Vol. I, pp. 396, 404.
[2] *Ibid.*, p. 407.

From a perusal of this table, it will be at once evident that the great difference in the matter of size alone, would be a sufficient distinction between *Dinotherium pentapotamiæ* and *D. indicum*, even if there were not differences in the form of the teeth themselves, which I shall point out when I come to the description of those of the latter species. The jaw of *D. pentapotamiæ* is less compressed than that of *D. indicum ;* if the jaw of the latter at the second premolar had the proportions of the former at the first true molar, it would have a width of 6·1 inches in place of only 5·1 inches, which is its real width. The less elliptical cross-section of the jaw of *D. pentapotamiæ* is a character in which it approaches typical *Mastodons*. The specimens are too imcomplete to admit of any more elaborate comparison of the form of the jaw. With regard to *D. giganteum*, there is a closer resemblance in the matter of size between it and *D. pentapotamiæ ;* indeed, if we compare together the larger teeth of the latter, and the smaller teeth of the former, we might possibly find specimens which showed extremely little difference in the matter of size. This, however, would obviously be an unfair method of comparison, since we ought to compare together the large teeth of one species with the large teeth of the other, and *vice versâ*. If such a comparison be made, it will always be found that the teeth of *D. giganteum* are considerably larger than those of *D. pentapotamiæ*. Further, the last lower true molar of the latter species has a much larger hind talon than the corresponding tooth of the larger European species, and there seems to be generally a greater tendency to a development of the longitudinal bridge in the lower molars of the former than in those of the latter species. In my previous notice of the molars of the same species, I have pointed out certain distinctive characters of the upper molars, among the most important of which, is the complete blocking of the lower portion of the outer extremity of the transverse valley in the second upper true molar, a character which causes the structure of that tooth to approach to that of a premolar. These combined differences, together with those which I shall immediately show to occur in the form of the last upper premolar, confirm the conclusions previously arrived at, as to the specific distinctness of *Dinotherium pentapotamiæ*.

It may be not out of place to notice that in teeth which are constructed on such an exceedingly simple plan as are those of *Dinotherium*, the variations in form which they are capable of undergoing must of necessity be extremely small, and there is consequently in most cases very great difficulty in deciding the specific identity or distinctness of isolated teeth, as has been remarkably illustrated in the case of the European forms of the genus. Any constant point of difference in the teeth, however small, must, I think, in consequence of this small amount of possible variation, always be regarded as of specific value.

Last upper premolar.—The last tooth of the present species, which calls for notice here, is the specimen represented in fig. 3 of Plate XXXI, which is the last upper premolar of the left side, and which has not previously been described. The preceding or penultimate upper premolar of the right side has already been figured in Plate IX, fig. 1, of an earlier fasciculus of this volume.[1]

[1] "Molar Teeth and Other Remains of Mammalia."

The tooth under discussion was obtained by Mr. W. T. Blanford from the Siwalik (Manchar) rocks of Sind; it is in an intermediate condition of wear, and has unfortunately lost a portion of the centre of its hinder ridge, and the outer extremity of the anterior ridge. The crown is approximately square, and carries two transverse ridges, of which the anterior one (left side of figure) extends completely across the crown, with only a slight depression near the middle, while the posterior is interrupted by a wide and deep gap. These gaps or depressions in the transverse ridges show that the tooth does not belong to the true molar series, in which the ridges are uninterrupted. At the outer side of the crown (top of figure) the two ridges are connected by a low wall with a V-shaped gap in the middle; on the inner side (lower border of figure) the transverse valley slopes down between the extremities of the ridges, without any tubercle at its entrance. The inner extremities of the ridges are wider and more worn than the outer. On the dorsal, or outer surface of the tooth, there is a deep vertical groove, occupying the space between the extremities of the two ridges. The tooth is distinguished at once from the penultimate premolar (Plate IX, fig. 1) by the greater continuity of the transverse ridges, and by the absence of the high and externally flat wall which forms the outer side of that tooth. The dimensions of this tooth are compared below with those of a corresponding tooth of *D. giganteum* from Eppelsheim, in the collection of the Indian Museum :—

	D pentapotamiæ.	*D. giganteum*
Length of outer border	2·1	3·0
„ „ inner „	2·0	2·1
Width of last ridge	2·5	3·2

The tooth of *D. giganteum* is rather a small specimen. On comparing together the two teeth, it will be found that the crown of the Indian tooth is more nearly square than that of the European; the groove on the outer surface is considerably deeper in the former than in the latter; the anterior ridge is less complete in the European tooth, and the two outer extremities of the ridges are more closely connected than in the Indian tooth. In the latter there is no trace of the tubercle which occurs at the entrance of the transverse valley in the former.

I have lately made a comparison of the penultimate upper premolar of *D. pentapotamiæ* (Plate IX, fig. 1), with a corresponding tooth of *D. giganteum* from Eppelsheim, and I find that the European tooth is more square (this is especially exemplified in some of Kaup's figures)[1] than the Indian; that the hind column (representing the inner extremity of the second ridge) extends further across the tooth in the former. The entrance to the transverse valley is blocked by a conical tubercle in the European tooth, while in the Indian the valley is extended outwards by a kind of spout-shaped projection; there are also differences in the shape of the cingulum, which are not easy to describe. The differences between the premolars confirm the conclusions previously arrived at, as to the specific distinctness of the Indian form.

[1] Kaup, *loc. cit.*, Plate II, fig. 6.

Correction.—The perfect state of preservation of the specimens represented in the accompanying plates of this memoir, has shown me that I was misled as to the structure of the imperfect lower molar from Sind represented in fig. 5 of Plate IX of an earlier fasciculus of this volume.[1] In that specimen I considered the prominence on the right side of the figure as being a true transverse ridge, and consequently that the tooth was a three-ridged one, of which the first ridge was broken away: the specimen was accordingly considered as the first lower true molar. A comparison of that tooth with the last lower molar of the specimen represented on Plate XXX will, however, at once show that the prominence on the right side of the broken tooth is in reality merely a talon-ridge, and consequently that the tooth is, in truth, the last, and not the first, lower true molar.

Dentition of D. pentapotamiæ.—Taking the specimens of the teeth of *D. pentapotamiæ* described here, together with those figured and described in the earlier fasciculus of this volume (Plate IX), we are now acquainted with the greater part of the permanent dentition of the species. The known teeth are, in the upper jaw, the two premolars, and the first and second true molars, and in the lower jaw the last premolar, and the three true molars. The following table gives the dimensions of all these teeth, together with those of *D. giganteum*:—

		D. pentapotamiæ.	*D. giganteum.*
Upper jaw.	Length of penultimate premolar	2·3	3·4
	Width of ditto ditto	2·1	3·1
	Length of last premolar	2·1	3·4
	Width of ditto	2·5	3·7
	Length of first true molar	2·75	4·1
	Width of ditto	2·4	3·2
	Length of second true molar	2·7	3·9
	Width of ditto	2·4	3·6
Lower jaw.	Length of last premolar	1·8	3·3
	Width of ditto	1·74	2·7
	Length of first true molar	2·34	3·6
	Width of ditto	1·8	3·0
	Length of second true molar	2·4	3·3
	Width of ditto	2·15	2·9
	Length of third true molar	2·9	3·8
	Width of ditto	2·25	2·45

The proportionate relations of the upper molars of the two species show that those of *D. pentapotamiæ*, which have all been found as detached specimens, are rightly referred to one and the same species.

Species 2: Dinotherium indicum, Falconer. Pl. XXXI, figs. 1 & 2.

History.—We have now to consider two other molars of an Indian *Dinotherium*, which are of larger size than any of the previously described specimens, and which also differ from them, to a considerable extent, as regards form. From considera-

[1] *loc. cit.*

tions which will be detailed below, these teeth have been referred to *Dinotherium indicum* of Falconer, the history of which species has already been referred to when treating of the preceding species of the genus.

Second upper true molar.—The first of the two specimens in question is the half of an upper molar represented in fig. 1 of Plate XXXI. This specimen was sent to the Indian Museum among a small collection of Punjab, and other North Indian fossils made by the late Dr. Verchere, and appears to have been obtained from the Siwaliks of Dehra Ghazi Khan, on the north-west frontier. This specimen, together with another tooth described below, has been already shortly noticed by me in the "Records."[1] The fragment consists of the hinder ridge of the second left upper true molar. The position of the tooth is determined by there being a disc of pressure on the remaining ridge, indicating the presence of another tooth on this side, and by the width of the ridge being equal to that of the valley, in place of being narrower, which it would be were the tooth the third true molar. The concave side of the ridge shows that this is the hinder side of the tooth, and the broken tubercle on the lower border of the figure shows that this border is the inner side of the tooth. The great general size and width of the ridge shows that the tooth cannot be the first true molar. The one remaining ridge is but slightly abraded by detrition, the enamel not having been perforated; the plane of wear slopes towards the anterior side of the specimen.

Since the corresponding molar of the smaller *D. pentapotamiæ* has already been figured on Plate IX, fig. 3, and described on page 73 of an earlier part of the present volume,[2] it will be simpler to commence by comparing these two teeth together at once, instead of describing the larger tooth separately.

Placing the two figures side by side, it will at once be seen that the tooth of *D. indicum* is widely distinguished from that of *D. pentapotamiæ* by its greatly superior size. In addition to this distinction, however, there are points of difference in the form of the two teeth, which afford more certain grounds for the specific distinctness of the two animals to which they belonged. It will be observed that the single ridge of the larger tooth is considerably straighter, and has a much slighter cavity on the posterior side, than has the corresponding hinder ridge of the smaller tooth. Again, the comparatively flat hinder surface of the larger tooth is entirely uninterrupted by ridges or projections, whereas the corresponding surface of the smaller tooth has a very distinct curved ledge, or cingulum near its base, and an imperfect ridge somewhat higher up. In the transverse valleys of the two teeth, another important distinction presents itself; in the smaller tooth the outer extremity of that valley is blocked by a low wall, which is the highest part in the whole valley; in the larger tooth, on the other hand, the valley is perfectly open externally, the middle point of the valley being the highest, from which point it slopes away rapidly on either side. In both the larger and smaller teeth there is a very large rounded

[1] Rec. Geol. Surv. of India, Vol. XII, p. 42.

[2] "Molar Teeth and other Remains of Mammalia" (volume paging).

tubercle placed at the inner entrance of the transverse valley. From the height of the centre of the transverse valley in the larger tooth, it appears that in the complete tooth there must have been a slight longitudinal bridge, connecting the transverse ridges. The larger tooth is further distinguished from the smaller by the much greater thickness of the enamel. In the following table I have compared together the dimensions of the two teeth, together with those of the corresponding tooth of the European *Dinotherium giganteum*:—

	D. indicum.	*D. giganteum.*	*D. pentapotamiæ.*
Width of last ridge	3·7	3·4	2·3
Thickness of base of ridge	1·8	1·6	1·1
Thickness of enamel	0·25	0·18	0·09

Although, from its incomplete state, we are unable to compare the whole of the larger tooth with the corresponding tooth of *Dinotherium pentapotamiæ*, yet the comparisons we have made are, I submit, sufficient to show the specific distinctness of the two. It now remains to see to what species the larger tooth should be referred. If we turn to the "Palæontological Memoirs" of Dr. Falconer,[1] we shall find that the fragmentary molars and lower jaw of *Dinotherium indicum* are of somewhat larger size than those of *D. giganteum*, while the former are further distinguished by the great thickness of their enamel. In both these characters the imperfect tooth described above agrees with Dr. Falconer's specimen, and I have therefore referred it to the same species.

Dr. Falconer, in the notice mentioned above, has shown in what respects the lower jaw of *Dinotherium indicum* differs from the lower jaw of *D. giganteum*. The fragmentary upper molar of the former species is distinguished from the corresponding tooth of the latter by its larger size and thicker enamel, by the great size of the tubercle at the inner extremity of the transverse valley (which is very small or wanting in *D. giganteum*), and by the elevation of the middle of the transverse valley.

First lower true molar.—The only other tooth of *Dinotherium* in the Indian Museum which I can refer to the same species, is the specimen represented in fig. 2 of Plate XXXI, which was collected by Mr. W. T. Blanford in the Laki hills of Sind. The specimen is a complete three-ridged tooth, with all three ridges well worn. From the number of ridges it might be one of the "intermediate" molars of a trilophodont *Mastodon*, but the absence of any trace of a median longitudinal cleft across the ridges, together with other characters which I shall subsequently notice, shows that it cannot belong to a *Mastodon*, and that it must therefore be referred to a species of *Dinotherium*. In the latter genus a three-ridged tooth can only be either a last milk-molar or a first true molar; the great size of our specimen shows that it cannot be a milk-molar, and it must consequently be a first true molar. The large size of the antero-posterior diameter in relation to the transverse, together with the convexity of the ridges being on the hinder side, shows that the

[1] Vol. I, pp. 396, 404.

tooth is the first lower true molar, while the greater height of the inner extremities of the transverse ridges (top border of figure) shows that the tooth belonged to the left ramus of the mandible. The tooth, therefore, corresponds to the second tooth (counting from the left) in the left ramus of the mandible of *Dinotherium pentapotamiæ* represented on Plate XXX; the two teeth are almost in the same relative condition of wear, which will greatly facilitate our comparison.

It will firstly be noticed that there is a very great difference in the matter of size alone in the two teeth, which, as far as it goes, would lead us to refer the two to distinct species. There are, however, more important points of differences in the form of the two teeth which I now proceed to consider. The larger tooth is distinguished by having on its outer and hinder surfaces a very stout and thick cingulum, extending from the middle of the anterior ridge (left side of figure) along the outer and posterior surfaces; (in the specimen this cingulum has been broken away on the posterior surface, but the fractured surface shows its former extent); no trace of this cingulum is to be seen on the smaller tooth. Again in the smaller tooth, the worn surfaces of the first and second ridges are united by a longitudinal bridge of dentine, while in the second and third ridges the worn surfaces are still separated by the transverse valley. In the larger tooth, all three of the worn surfaces of the ridges are still separate, but it will be seen that the second transverse valley is as nearly obliterated as the first, and that consequently the worn surface of the third ridge would be united to that of the second, as soon as the latter would to that of the first. Finally, the enamel of the larger tooth is very much thicker than that of the smaller. In the following table the dimensions of the first lower true molars of *Dinotherium pentapotamiæ* and *D. giganteum* are compared with those of the corresponding new tooth:—

	New tooth.	*D. giganteum.*	*D. pentapotamiæ.*
Length of tooth	3·9	3·5	2·35
Width of first ridge	2·5	2·6	1·8
Ditto of second ditto	2·5	2·6	1·8
Ditto of third ditto	2·4	2·2	1·7
Thickness of enamel	0·25	0·19	0·11

These differences in size and form make it clear that the new tooth cannot belong to *D. pentapotamiæ*. In the lower jaw of *Dinotherium indicum* described by Dr. Falconer from Perim Island,[1] the crowns of the molars have unfortunately all been broken off, and we cannot therefore compare the form of the first lower molar of that specimen with the Sind tooth. The bases of the molars, however, remain in the Perim Island jaw, and the dimensions of the first true molar, as given by Dr. Falconer,[2] are as follows: Length 4 inches, width behind 2·8 inches. Now, we have already seen that the Sind tooth is slightly broken, and that therefore its length, where complete, must have been almost exactly equal to the Perim Island tooth; the latter, however, is rather the wider of the two. As the Sind tooth

[1] Palæontological Memoirs, *loc. cit.*
[2] *Ibid*, p. 407.

agrees so closely in size with the Perim tooth, and also with the upper molars of the same species in the thickness of the enamel, I have referred it to the same species.

The first lower molar of *D. indicum* agrees with the other remains of the same species in being slightly larger than the corresponding tooth of *D. giganteum*. The presence of the large cingulum on the former distinguishes it from the latter.

Distribution.—The distribution of *Dinotherium indicum* now extends from Perim Island through Sind to the north-western Punjab.

Characters.—The species is still very imperfectly known. It appears to be the largest known species of the genus, and is mainly characterized by its thick enamel. Dr. Falconer thought from the study of the jaw, that he could trace indications of a closer affinity with the *Mastodons,* than exists in other species of the genus. It is much to be hoped that we may eventually discover the skull of this and the other Indian species.

Species 3: Dinotherium sindiense, n. sp. nobis. Pl. XXXI, fig. 4.

Besides the two foregoing species of *Dinotherium,* we have one specimen of a lower jaw in the Indian Museum, which indicates the existence of a third Indian species of the genus, which must have been of very small size, and which I propose to call *Dinotherium sindiense,* as the specimen in question was obtained in Sind by Mr. Fedden. A notice of the discovery of this specimen has been previously given in the "Records."[1] The specimen is represented of the natural size in fig. 4 of Plate XXXI, and will be seen to consist of a fragment of the hinder part of the right ramus of the mandible, carrying two broken molars. Although these molars are considerably damaged, enough of them remains to determine their serial position. The tooth on the left side of the figure will be clearly seen to be a molar, which originally carried two ridges and a large hind talon, and in fact corresponded in form to the molar on the right hand of the jaw represented in Plate XXX, the two specimens belonging to opposite sides of the mandible. This tooth therefore is the last lower true molar, and the preceding more broken tooth (on the right side of the figure) will consequently be the second true molar. The position of these teeth being determined, it follows that the jaw belonged to a fully adult animal, and that it cannot be a young specimen with the milk-dentition, in which case the last tooth would have had three ridges.

Although the teeth of this specimen are considerably smaller than the corresponding teeth of *Dinotherium pentapotamiæ,* I should not, probably, on these grounds alone, have referred the Sind mandible to a different species. The form of this new lower jaw is, however, so totally different from the lower jaw of *D. pentapotamiæ,* of which the teeth are represented in Plate XXX, that there can be no

[1] Rec. Geol. Surv. of India, Vol. XII, p. 43.

question but that they belong to distinct species. In the following table the corresponding dimensions of the two specimens are compared together :—

	D. pentapotamiæ.	*D. sindiense.*
Length of second molar	2·4	2·3
Width of ditto	2·15	1·55
Length of third molar	2·9	2·5
Width of ditto	2·25	1·9
Depth of jaw at second molar	5·3	3·1
Ditto at third molar	5·8	3·3
Width of jaw at second molar	3·4	2·9
Ditto at third molar	4·1	3·5

The great difference in the shape of the two jaws will be gathered from a perusal of the foregoing table. The lower jaw of *D. pentapotamiæ* is laterally compressed, though, as before said, to a somewhat less extent than that of some other species, and its vertical diameter is consequently very much greater than its transverse diameter. In *D. sindiense,* on the other hand, the lower jaw is nearly cylindrical, and at the last true molar the transverse diameter is greater than the vertical diameter. Whereas the lower jaw of *D. pentapotamiæ* on its outer side descends vertically down from the teeth, that of *D. sindiense* is expanded into a distinct ledge below the roots of the molars.

It is unfortunate that the molars of *D. sindiense* are in such a battered condition, so as to preclude any exact comparison with those of *D. pentapotamiæ,* but the differences in the size and form of the two jaws are amply sufficient to afford grounds of specific distinction. In its cylindrical form, indeed, the lower jaw of *Dinotherium sindiense* seems to differ from the jaws of all other known species of the genus : from its sub-circular cross-section and generally slender form, I think it not improbable that this species of *Dinotherium* was unprovided with a long deflected symphysis and mandibular incisors. In all other species of *Dinotherium* the mandible is laterally compressed to offer more resistance to the enormous weight of the symphysis and tusks, and in all *Mastodons* with a long heavy symphysis and mandibular tusks (*M. angustidens, M. longirostris, M. pandionis*), the rami of the mandible are similarly compressed. If this suggestion should turn out to be true, it may be necessary to form a new genus for *D. sindiense.* In its sub-cylindrical mandible this species shows affinity to the *Mastodons* with short mandibular symphyses.

Family II—ELEPHANTIDÆ.

Proboscidia in which there are never more than three teeth in use at the same time, and in which the number of ridges in the second true molar is either equal to, or greater than, the number in the preceding tooth.

Dentition of the Elephantidæ.

The dentition of the *Elephantidæ* is perhaps more remarkable than that of any other group of the Mammalia, in regard both to the structure of the teeth and in their mode of succession, and is evidently the product of a long course of specialization. With regard to the structure of the teeth, I shall not enter into details here, since this has been most amply illustrated by Falconer,[1] Owen[2] and other writers. With regard to the number and succession of the teeth, a short notice is necessary, in order that the reader who has not specially studied the dentition of this interesting group may have no difficulty in following the descriptions given in the sequel.

It will not be necessary to notice the systems of classification proposed for the molars of the *Elephantidæ*, before their homology was thoroughly understood, which has been already lucidly done by Dr. Falconer,[3] and I therefore proceed at once to the classification of those teeth as given by the last-named writer.

In the living Indian elephant, it has been demonstrated that six grinders are developed in a horizontally succeeding series, on either side of both upper and lower jaws, and that the hinder teeth are more complex than the anterior. The whole of these teeth are never in use at any one time, the anterior ones falling out as they are worn down, and the posterior ones gradually coming into use and replacing them; the animal when quite adult has only the last molar in use, the length of wear of which of course determines the life of its owner. There are never more than three teeth on one side of either jaw in use at any one time.

The *Mastodons* present a like number of horizontally succeeding teeth. Of these six teeth in that group, the third, fourth and fifth usually carry the same number of ridges, and have hence been termed by Dr. Falconer the "intermediate" molars. In the Trilophodont section of the group the number of ridges on each of these three teeth is always three, and in the Tetralophodont, normally four; the tooth (of the horizontal series) immediately in front of the first "intermediate" molar, has always one ridge less than the latter, and the tooth behind the third "intermediate" molar, one ridge more than that tooth. The serial position of these teeth is, therefore, generally pretty easy to determine, since the three isomerous "intermediate" molars increase regularly in size from the first to the third.

Of these six teeth, it will subsequently be shown that in many species of *Mastodons* and in one elephant, the second and third (and sometimes the first) are replaced by vertically succeeding teeth, which consequently correspond to the premolars (*dents des remplacement*) of the normal mammalian dentition, as exemplified in the Pig. The three first teeth in the horizontal series must therefore correspond to the last three teeth of the milk dentition of the Pig, and may therefore be called

[1] Pal. Mem., Vol. I, p. 43, et seq. Fauna Antiqua Sivalensis, Pls. I & II.
[2] Odontography, p. 613 et seq.
[3] *loc. cit.*

the antepenultimate, penultimate, and last milk molars, respectively.[1] The three last teeth in the same series, as being developed behind and after the milk-molars, must consequently correspond to the true molars of the Pig; and are, therefore, called respectively the first, second and third true molars.

Now we come to the consideration of the *dents des remplacement* or premolars, the succession of which requires a little more discussion. In a memoir on elephant and *Mastodon*, by Dr. Falconer,[2] published in part in 1846, the writer seems to have been of opinion that apparently in all *Mastodons* only the penultimate milk-molar was succeeded by a premolar (*dent de remplacement*). This conclusion seems to have been previously arrived at by Professor Owen, who retains it up to the late date of 1861.[3] Dr. Falconer, however, in a subsequent paper,[4] announced that in many species, at least, two premolars were developed, which I infer, though this is not clearly expressed, replace the second and third milk-molars. That the last upper milk-molar was succeeded by a '*dent de remplacement*' is proved by the specimens drawn in figs. 6 and 8 of Plate XXXVII of this memoir, as well as by many other foreign specimens, from which we arrive at the conclusion that the two last milk molars were respectively replaced by vertically succeeding premolars in the upper jaw: other specimens (especially a fine lower jaw of *M. angustidens*) show that the two last lower milk-molars were similarly replaced.

Although it is frequently difficult, as will be noticed in the sequel, to refer detached milk-molars and premolars to their proper serial position, there is never any difficulty when the teeth occur in the jaw. When all the teeth in a *Mastodon* jaw belong to the milk and true molar series, any one tooth is more worn than the tooth immediately behind it: when premolars are present, on the other hand, the last premolar is less worn than the tooth immediately behind it, whether such tooth be a milk-molar or the first true molar.

Besides the penultimate and last milk-molars, there is good evidence that in one species of *Mastodon*, at least, an antepenultimate premolar was also developed. In a young upper jaw of the American trilophodont *M. productus*, figured and described by Professor Cope,[5] in front of two three-ridged teeth, which from their isomerous ridge-formula, must be the first and second "intermediate" molars, or respectively the last milk-molar and the first true molar, there are developed two small teeth, which are less worn than the third milk-molar, and which consequently are true "*dents des remplacement*," or respectively the antepenultimate and penultimate

[1] For the sake of brevity in the text, I have usually termed these teeth, respectively, the first, second and third milk-molars, though, of course, they really correspond to the second, third and fourth of the milk-molars of the typical series. According to Falconer the pre-antepenultimate milk-molar is occasionally developed as an abnormality in the African elephant.

[2] *loc. cit.*, p. 95.

[3] "Odontography," p. 615, ed. 1840-45. "Palæontology," p. 388, ed. 1861.

[4] *loc. cit.*, Vol. II, p. 11 (published in 1857).

[5] "Extinct Vertebrata of New Mexico." U. S. Geographical Survey, W. of 100th merid., Vol. IV, Pt. II, p. 309, Pl. LXXI, fig. 1.

premolars. We have therefore now proof that all the milk-molars of *Mastodons* may be replaced by premolars.

I shall, I hope, be pardoned for pointing out what appears to me to be a want of precision in Professor Cope's description of the above-mentioned teeth. In that description the learned author, speaks of all the three anterior teeth as "premolars," apparently not recognizing their belonging to totally different series, though he mentions that the last "premolar," according to Owen, belongs to the milk-series. This fusion under one serial name, of teeth belonging to two totally different series, is a retrograde step from Falconer's clear definitions. It does not appear that Professor Cope recognized the importance of his specimen in further elucidating the dentition of the *Mastodons*.

Although we have thus seen that the antepenultimate and penultimate milk-molars may be replaced by premolars it appears to me that certain pre-molars of *M. angustidens* classed by the late Professor Herman von Meyer as the antepenultimate and penultimate, are really the penultimate and last. In a left maxilla of a young *M. angustidens* figured by that distinguished palæontologist[1], there are seen three teeth, the two first of which are less worn than the third, and which are consequently premolars; the third tooth carries three ridges, and, the species being trilophodont, might be either the last milk-molar or the first true molar. By von Meyer the three-ridged tooth is classed as the third milk-molar (*dritter milch backenzahn*), while the two premolars are respectively classed as first and second (*erster und zweiter erzatzbackenzahn*). This first and second, as being in front of the third milk-molar, must be equal to penultimate and antepenultimate. In fig. 12 of Plate V of the same memoir, von Meyer figures a two-ridged premolar, which he calls the second or penultimate (*zweiter ersatzbackenzahn*). Now, in a cast of a young lower jaw of *M. angustidens* in the Indian Museum, below a three-ridged tooth, there is seen in its alveolus a replacing premolar, which is similar to, though smaller than, von Meyer's lower premolar; the former, as replacing the last milk-molar must be the last or third (fourth of the typical series) premolar, from which I infer that von Meyer's is the same.[2] Again, in the upper jaw the two premolars are far larger and more complex than the antepenultimate and penultimate premolars of *M. productus*, and I therefore think it is pretty clear that the former teeth really are the two last of the premolar series. The third tooth in von Meyer's specimen will consequently be, if I am right, the first true molar. I shall have to refer to this question again, as it has an important bearing on the determination of certain teeth figured in this memoir. I may also mention that in fig. 16 of Plate V of the same memoir von Meyer has figured a detached three-ridged lower molar of *M. angustidens*, as the second lower milk-molar (*zweiter milch backenzahn*); this tooth, I think, is certainly the third milk-molar. The second lower milk-molar, as seen in a specimen from Eppelsheim in the Indian Museum (preceding a three-ridged tooth, and with the pressure-mark of a preceding tooth anteriorly) is a two-ridged tooth; the third milk-molar, succeeding the second, in the

[1] Palæontographica Vol. XVII, Pl. III, fig. 1.
[2] See "Les Enchainements du Monde Animal," fig. 242.

above specimen, is quite like von Meyer's specimen, but rather smaller. If von Meyer's determination be not erroneous, Falconer's ridge-formula for this *Trilophodon* will not hold.

It thus appears that among the *Mastodons*, all together nine molar teeth may be developed, which may be tabulated as follows :—

			Intermediate molars.			
Horizontal series . . .	1	2	3	4	5	6
	Milk-molars.			True molars.		
	(2	3	4)	(1	2	3)
	(of type series.)			(of type series.)		
Vertical series . . .	1	2	3			
	Premolars.					
	(2 3 4 of type series.)					

Or

Milk-molars $\frac{3-3}{3-3}$ Premolars $\frac{3-3}{3-3}$ True molars $\frac{3-3}{3-3}$

In all species the whole of the horizontal series is always developed; of the premolar series in one species, the two first (and probably also the last) are developed (*M. productus*) ; in others only the two last (*M. angustidens*, according to Falconer's and my own view, and *M. latidens*), and in others none (*M. giganteus*, *M. sivalensis*).

In the elephants, premolars are only known to be developed in one species (*E. planifrons*): all the horizontal series are developed, but the isomerous ridge-formula of the intermediate molars is not preserved in the more specialized forms.

We now come to the consideration of the rest of the dentition of the *Elephantidæ*, which need not detain us long. In the upper jaws of all species there are normally developed a single pair of tusk-like incisors, which apparently correspond to the outer pair of the three typical mammalian incisors. In the females these tusks are usually smaller than the male ; in some species, however, (*E. africanus*), the tusks are frequently large in both sexes. In one variety of the Indian elephant the Múkna (Mooknah), the tusks of the male are small, like those of the female. In the living species, and certainly in some fossil species, of *Elephantidæ*, the permanent tusks were preceded by deciduous tusks : it is probable that this replacement occurred in all members of the family.

In many *Mastodons* (*M. longirostris*, *M. angustidens*) a pair of tusk-like incisors were also developed in the lower jaw, but it is not known whether these were preceded by deciduous incisors. In, at all events, one species (*M. angustidens*) inferior tusks were developed in both sexes ;[1] in others (*M. longirostris*, *M. perimensis*) in only one sex, which was doubtless the male : in other species again (*M. sivalensis* *M. latidens*, *M. falconeri*), there appear to be no lower incisors ever developed. In no elephant is there ever any trace of lower incisors.

It will be apparent from the above summary that no generic determinations of the *Elephantidæ* can be made from the presence or absence of certain teeth.

[1] Prof. Owen, "Odontography" p. 615, gives no lower tusks to the females of all species, but to all males of the genus.

Genus 1: MASTODON, Cuvier.

Elephants in which the number of ridges in the intermediate molars is never greater than five, and in which cement is either entirely absent, or present in comparatively small quantities.

Section A.—Trilophodon, Falconer.

Intermediate molars with three ridges only.

Species 1: Mastodon falconeri, n. sp. nobis. Pls. XXXII & XXXIII.

History.—This species of Siwalik trilophodont *Mastodon* has been hitherto known chiefly by name only, since in the previously published notices of the molars upon which I founded the species, I did not give any detailed descriptions, but merely stated that I thought that these teeth were distinct from those of *Mastodon pandionis* (the only other Indian species of the genus with a ternary ridge-formula), and also from those of all other species of the genus. The first notice of this species will be found in the "Records,"[1] where two lower molars are noticed: a second notice of the imperfect cranium of a young animal and of some detached molars was given subsequently.[2] Since these two preliminary notices were published, several additional molars of the species have been obtained by different Officers of the Survey, and the more perfect specimens from this collection are now for the first time described and figured under the name of *Mastodon falconeri* (Lyd.), which was originally proposed by me for the teeth noticed in the "Records."

Specimens figured.—The molars figured in the present memoir comprehend the second and third upper milk-molars, the first and second upper true molars, the second lower milk-molar, and the first and second lower true molars. This series of teeth affords us ample material for showing the distinctness and affinities of the species, though it is to be hoped that subsequent researches may bring to light a complete cranium, in order that we may compare this with the cranium of such of the Siwalik species in which it is known.

Second upper milk-molar.—The two upper milk-molars represented in figs. 2 and 3 of Plate XXXII belong to the imperfect and much crushed cranium of a young individual noticed above, which was obtained by Mr. Theobald in 1877 from the Siwaliks of the Punjab. The smaller of these two teeth (fig. 2) is evidently from its size and shape the second upper milk-molar of the left side.[3] The specimen was implanted in the jaw by two fangs, the hinder one of which is considerably the larger of the two. The form of the crown-surface is rudely oblong, and is narrower

[1] Rec. Geol. Surv. India, Vol. X, p. 83.
[2] *Ibid.*, Vol. XI, p. 70.
[3] This tooth, being more worn than the succeeding tooth (fig. 3), must be a milk-molar, and not a premolar.

in front than behind; the triturating surface carries two main transverse ridges separated on the outer side (top of figure) by a wide and open valley, but on the inner side in contact. Each of these transverse ridges is mesially divided by an antero-posterior cleft into a distinct inner and outer column, of which the latter is the higher. In both columns of the anterior ridge the enamel has been perforated by trituration; the inner column of the second ridge also exhibits a considerable islet of dentine, while the outer column of the same ridge has merely its summit obliquely abraded, but the enamel not perforated: the dentine islets are in the form of irregular disks. In advance of the first transverse ridge there is a small and narrow talon, somewhat broken in the specimen, and on which the dentine is exposed by wear; behind the second transverse ridge there is also another talon, of unusually large size, and carrying a distinct tubercle at its inner extremity. There is a small tubercle at the outer extremity of the main transverse valley. The length of this tooth is 1·8 inches and its greatest width 1·6 inches.

Third upper milk-molar.—The larger tooth (fig. 3) immediately succeeded the preceding specimen in the young cranium, and is consequently the third, or last, upper milk-molar of the left side. This tooth is implanted in the maxilla by four distinct fangs; the crown is oblong in shape and carries three transverse ridges and fore-and-aft talons. The presence of these three transverse ridges on this tooth, which is the first of the "intermediate" molars, proves that the cranium in question belonged to a trilophodont *Mastodon;* the corresponding and two succeeding teeth of a *Tetralophodon* would of course carry four ridges each. Each ridge, as in the preceding tooth, is mesially divided by an antero-posterior cleft into an inner and an outer column, and each ridge carries five cusps or denticles. The inner portion of both the second and third ridges is placed somewhat obliquely to the long axis of the tooth; the postero-internal angle of the last ridge joins the hind talon; there is a small but distinct tubercle on the hinder side of both the first and the second ridges; these tubercles at their junction with the centre of the next ridge very slightly block the bases of the transverse valleys; the latter are, however, mainly characterized by being fairly free and open. The anterior talon is small, and its cusps indistinct; the posterior talon is larger, and its cusps, especially the three on the inner side, are of large size and well defined. There is a faint trace of abrasion on the anterior ridge of this tooth, otherwise it is untouched by wear. The length of the specimen is 3·04 inches and its width 2 inches.

Young cranium.—The imperfect cranium of a young individual of *Mastodon falconeri,* to which the two last described milk-molars belong, is in much too damaged a condition to afford a figure, or indeed any idea of the form of the perfect cranium. Behind the tooth, which has been described above, there occurs in that cranium the germ of a third tooth which, like its predecessor, carries three transverse ridges, and which from its position must be the first true molar. This tooth agrees in general characters exactly with the last milk-molar described above; as it cannot

be thoroughly cleaned from matrin, I have not given a figure of it. Its length is 3·5 inches, and its greatest width 2·2 inches.

First upper true molar.—The much worn tooth represented in fig. 4 of Plate XXXII has a very convex masticating surface, and therefore belongs to the upper molar series, and to the left side of the cranium, as is shown by the curvature of the ridges; as it agrees so closely in size with the last-mentioned specimen, and carries three transverse ridges, it must be the first true molar. The first and the third ridges are the most worn, all traces of the median longitudinal cleft having been obliterated in these ridges; in the second ridge a portion of this cleft still remains, the masticating surface being consequently divided into two incomplete dentine islands, of which the one on the lower side of the figure is the larger; this side is consequently the inner side of the tooth. The length of this specimen is 3·6 inches, and its greatest width 2·3 inches.

This tooth is of great value, because it enables us to show that the first true molar of *Dinotherium indicum* represented in fig. 2 of Plate XXXI cannot belong to this species of trilophodont *Mastodon,* to which on first sight it might be assigned. It will be seen, on comparing together the two teeth, that though the tooth of the *Mastodon* is the most worn of the two, as is shown by its lower ridges and wider dentine surfaces, yet still a trace of a median longitudinal cleft remains in the second ridge, while in the much less worn *Dinotherium* tooth no such trace is visible. The latter tooth, as a minor character, is further distinguished by the much greater thickness of its enamel.

Second upper true molar.—The large tooth represented in fig. 1 of the same plate was collected by Mr. Theobald in the Punjab, and is an upper molar of the left side, and from its general characters evidently belongs to the same species as the last. Since this tooth carries three transverse ridges, and is larger than any of the preceding specimens, it must evidently be the last of the 'intermediate' molars, or, in other words, the second true molar. The greater portion of the anterior ridge and talon of this tooth has been broken away, though the other two ridges are complete; the median ridge, and especially its inner column, has been considerably abraded by detrition; the enamel of the last ridge is not perforated. A distinct median and longitudinal cleft divides each ridge into an inner and an outer column: in each of the two transverse valleys there is a tubercle on the inner side of the median cleft closely applied to each side of the ridges. There is in consequence a slight obstruction at the bottom of each of the valleys which are, however, mainly characterized by being free and open; a large blunt tubercle occupies the mouth of the inner side of each valley. The ridges are nearly straight, which seems to indicate that the curvature which we observed in the last milk-molar gradually dies out in the succeeding teeth; the ridges when unworn seem to have carried cusps like those of the preceding teeth. The posterior talon carries two distinct cones, the innermost of which is the larger of the two. The enamel is smooth and of considerable thickness; the dentine islands of the inner columns

are distinctly trefoil-shaped, caused by the union of the lateral tubercles with the main column. The length of this tooth is 5·2 inches, and its greatest width 3·5 inches.

Second lower milk-molar.—Turning now to the lower molar series of this species, of which three specimens are figured on Plate XXXIII, we may first consider the smallest of the three. This specimen (fig. 2) was found by Mr. Theobald with the young cranium noticed above, and belonged to the same individual. The tooth is implanted in a small fragment of the mandible, the remainder of which seems to have been unavoidably destroyed during the process of extricating the specimen, which was in juxtaposition with other valuable fossils: the tooth is implanted in the fragment of the jaw by two fangs. The outline of its crown in plan roughly approximate to an isosceles triangle, of which the apex is placed anteriorly; the base of the triangle is somewhat damaged. The crown may be said to consist of two ridges, separated by a deep transverse valley, and of a hind talon. The anterior ridge has its longer diameter coincident with the longer diameter of the tooth, and consists of five agglomerated columns; the three anterior columns of this ridge exhibit small surfaces of dentine exposed by detrition. The dentine surface on the lower border of the figure is the most worn; this border, therefore, is the outer side of the tooth, which must consequently belong to the right ramus of the jaw. The second ridge has its transverse diameter longer than the antero-posterior, and runs somewhat obliquely to the long axis of the crown; it is divided by an indistinct median cleft. The external column of this ridge exhibits a plane of detrition on its anterior surface, but the enamel has not been perforated. The enamel, as in the upper milk-molars, is much corrugated. The fragment of the mandible in which the tooth is implanted is laterally compressed to a slight extent. The dimensions of the specimen are as follows:—

Length of tooth	2·12
Width of ditto	1·45
Height of crown of ditto	1·1
Depth of jaw	2·6
Width of ditto	2·0

We shall subsequently see that this slight lateral compression of the mandible is only a character of the young animal, or possibly of the anterior portion of the mandible in the adult.

With regard to the serial position of this tooth, it is evident that the specimen belongs to the milk-molar series, and also that it is of too large a size to be the first of the series, while it cannot be the third, as in that case it should carry three transverse ridges; it must, therefore, be the second of the milk-molar series, and must consequently correspond in position with the upper tooth represented in fig. 2 of Plate XXXII. The relative size of the two teeth agrees well enough together; the upper tooth, however, is somewhat more worn than the lower, which

appears to be the reverse of what occurs in other *Mastodons*. If, for instance, we refer to the figures of the upper and lower milk dentition of *Mastodon pentelici* and *M. tapiroides* (*turicensis*) given by Professor Gaudry,[1] we shall find that the lower teeth are somewhat more worn than the upper. As I have not the least doubt but that the two Indian teeth belong to the same cranium, we must assume that the relative position of the upper and lower milk-molars of *M. falconeri* was slightly different from that which occurs in *M. pentelici* and *M. tapiroides*: that is, that the second upper milk-molar was partially abraded by the first lower milk-molar in the former.

First lower true molar.—The next tooth we have to consider is the specimen represented in fig. 3 of Plate XXXIII. This specimen is an almost unworn germ of the crown, with the fangs broken off, collected by Mr. Fedden in the Laki hills of Sind. This tooth carries three transverse ridges and fore-and-aft talons; it is slightly larger than the first upper true molar in the young cranium noticed above, but is evidently the corresponding lower tooth. The column in the lower right-hand corner of the figure is very slightly abraded by wear, which shows that this side is the front of the tooth; from the flatness of the crown the tooth is evidently from the lower jaw, and from the accessory columns being placed externally to the median cleft, the tooth is as evidently of the right side, the arrangement of these columns being exactly the reverse of that which occurs in the upper molars.

The general form of the crown, as viewed in plan, is oblong, with an average, even width; the ridges are blunt and short, with fairly open valleys; each ridge is divided by a deep median longitudinal cleft into an outer and an inner column; the three inner columns carry two cusps each; the first outer column has a large accessory column or tubercle, placed at its antero-internal angle, on the outer side of the median cleft; a faint rudiment of another accessory column occurs on the postero-internal angle of the same main column. The outer column of the second ridge has a large accessory column on either side adjoining the median cleft; the outer column of the third ridge is divided into two cones by a cleft. The anterior talon (right side of figure) forms a broad projecting ledge on this side of the tooth, divided into numerous cusps, of which the one at the inner extremity is considerably larger than any of the others. The posterior talon consists of a low double ridge, the first of these minor ridges being the larger of the two, and bearing two large outer cusps, between which are three much smaller cusps; the second ridge of this talon consists of three or four ill-defined cusps. There is a slight rudiment of a tubercle at the outer extremity of each of the transverse valleys. In the centre of each of these valleys there is also a slight obstruction at the very base, caused by the approximation of the bases of the contiguous accessory columns. When worn down, the outer columns would evidently present distinct trefoil-shaped islets of dentine. The length of this tooth is 4·1 inches; its width 2·4 inches, and the height of its ridges 1·4 inches.

Second lower true molar.—Continuing our serial survey of the lower molars

[1] "Animaux Fossiles et Géologie de l'Attique," Atlas, Pls. XXII and XXIV.

we come to the large specimen represented in fig. 4 of Plate XXXIII. This tooth is implanted in a fragment of the right ramus of the mandible, represented on a smaller scale in fig. 1 of the same plate; in front of the figured tooth there is in the jaw a fragment of another much worn tooth, which is too imperfect for description; the jaw was collected by Mr. Theobald in the Punjab. The figured specimen carries three stout transverse ridges and a very large hind-talon, and is slightly narrower in front than behind. From its great size, and from the number of its ridges, it is quite evident that this tooth must be the second lower true molar, and that it consequently corresponds in serial position to the upper molar represented in fig. 1 of Plate XXXII; the two teeth, however, belong to opposite sides. The lower molar is considerably more worn down than the upper, since in the former large dentine islets are exposed on the third ridge, whereas in the latter, the enamel of that ridge is not perforated.

The lower molar is considerably the larger of the two, and probably belonged to a male animal; the two teeth, however, have essentially the same form and structure, and it will be needless to fully describe the lower tooth, and I will, therefore, content myself with pointing out how this tooth agrees with the upper tooth.

Both teeth, it will be observed, carry a very large hind-talon, which is divided into two columns, but less distinctly in the lower than in the upper molar. In the lower molar the accessory columns in the transverse valleys, on the outer side of the median longitudinal cleft, are somewhat more worn down than the corresponding columns, on the inner side of the same cleft, in the upper tooth, and the valleys are apparently blocked to a somewhat greater extent than in that tooth. The lower molar agrees with the corresponding tooth in the upper jaw (Plate XXXII fig. 1) in presenting trefoil-shaped islets of dentine exposed by detrition, in one of the columns of each ridge, when well worn down. These trefoils are situated on the inner columns of the upper, and on the outer columns of the lower molar. At the outer extremity of each transverse valley in the lower molar, there occur low blunt tubercles, the homologues of those situated at the opposite extremities of the valleys of the upper molars. A small anterior talon occurs in the lower molar, its exposed dentine islet being in direct connection with that of the first ridge; it is probable that a similar talon, which has been broken off, originally occurred in the upper molar.

Mandible.—The fragment of the mandible in which the last described molar is implanted (Plate XXXIII, fig. 1) comprizes the middle portion of the horizontal ramus of the right side. This fragment is of great thickness and presents a nearly circular transverse section below the last molar, the transverse diameter being slightly larger than the vertical. Its inner surface is nearly flat, but its outer surface is convex, both from above downwards and from before backwards, and bulges out suddenly below the crown of the molars. The lower border is highly convex[1]; where broken off at the commencement of the symphysis it has only a depth of

[1] This border in the figure is too straight.

about 4 inches, and is sub-circular in section. The dimensions of the ramus and molar are as follows :—

Length of last molar	6·4
Width of ditto	3·7
Height of hind-talon of ditto	2·2
Depth of jaw at last molar	6·4
Ditto at commencement of symphysis	3·9
Width of ditto (greatest)	6·9

From the arcuated form of the inferior border of the mandible, we infer that the mandible had a short symphysis[1], because in *Mastodons* with a long symphysis (*M. angustidens*,[2] *M. longirostris*,[3] *M. pandionis*[4]), the portion of the mandible below the molars has a straight, or slightly sinuous, inferior border, but never an arcuated one. The same inference is drawn from the sub-circular section of the mandible; the Proboscidia with long mandibular symphyses (*Dinotherium* [except *D. sindiense*], *M. angustidens*, *M. longirostris*, *M. pandionis*) having always a laterally compressed mandible. This lateral compression of the mandible is necessary to bear the strain of the great symphysis, it being a well known principle in engineering to have the larger diameter of your beams at right angles to the strain. Again, if *M. falconeri* had a long symphysis, the cross section of the ramus of the mandible at the symphysis, in place of being sub-circular, would have a thick base and a thin outer wall superiorly.

General characters.—The characteristic points of the molars of *M. falconeri* may be summarised as follows: "intermediate molars with three transverse ridges and large talons; ridges running directly across the crown of the tooth, and divided into inner and outer columns by an approximately mesial cleft; accessory columns, situated on the inner side of this cleft in the upper, and on the outer side in the lower molars, slightly blocking the middle of the transverse valleys; dentine islets of one column in each ridge trefoil-shaped[5]; blunt tubercles at the inner extremities of the valleys in the upper, and at the outer in the lower molars; no cement." The ridge formula of this species, as far as it is known, follows the normal trilophodont law, and may be written as follows :—

$$\text{Milk-molars. } \frac{1(?)+2+3}{1(?)+2+3(?)} \qquad \text{Molars. } \frac{3+3+4(?)}{3+3+4(?)}$$

From the absence of any trace of premolars in the young cranium noticed above, (in which the alveoli of the milk-molars have been cut into) it is almost certain that these teeth were not developed in this species. We know nothing regarding the

[1] See "Fauna Antiqua Sivalensis," Pl. XLIV, figs. 4, 16, 23 A.

[2] *Ibid.*, pl XLIV, fig. 5. "Abhand. der k. k. Geol. Reich.," Wien., vol. vii, pt. 4, 1877, pl. I.

[3] F. A. S. pl. XLV, fig. 10.

[4] See below.

[5] In the tooth drawn in Plate XXXII, fig. 4, it will be observed that the exposed dentine surfaces are of an irregular, and not of a trefoil-shape; this is owing to the great extent to which the tooth has been worn away.

form of the cranium. The mandible was sub-circular in section, and had a short symphysis.

In my first notice of the molars of this species in the "Records," it was stated that cement was present in these teeth; this I now find to be an error, into which I was led by the exfoliation of the enamel in those specimens.

Specific distinctness.—Our next point is to institute a comparison between the molars of *Mastodon falconeri* and those of other species of the genus, in order that we may be assured of its distinctness as a species. In this comparison, we may at once dismiss all species belonging to the section *Tetralophodon*, in which the "intermediate" molars never carry less than four transverse ridges, and we may accordingly confine ourselves to the trilophodont section of the genus. Of that section the following list gives the names of all the described species (exclusive of the present) with which I am acquainted, :—

1. *M. andium* (Cuvier)—N. America.
2. *M. angustidens* (Cuvier)—Europe.
3. *M. borsoni* (J. Hays)—Europe.
4. *M. humboldtii* (Cuvier)—S. America.
5. *M. maximus* (Cuvier)—America.
6. *M. obscurus* (Leidy)—N. America.
7. *M. pandionis* (Falconer)—India.
8. *M. pentelici* (Lartet and Gaudry)—Europe.
9. *M. productus* (Cope)—N. America.
10. *M. pyrenaicus* (Lartet)—Europe.
11. *M. tapiroides* (Cuvier)—Europe.
    (*M. turicensis*, Schinz).
12. *M. virgatidens* (Meyer)—Europe.

Commencing with *Mastodon angustidens*,[1] we shall find in the "Fauna Antiqua Sivalensis,"[2] figures of the third upper milk-molar and of the second upper true molar. These teeth correspond with the two molars of *M. falconeri* represented in figs. 3 and 1 of Plate XXXII of the present memoir. In the following table the dimensions of these four teeth are arranged side by side, *viz.* :—

	M. angustidens.	*M. falconeri.*
Length of third milk-molar	2·8	3·04
Width of ditto ditto	1·6	2·0
Length of second true molar	4·5	5·2
Width of ditto ditto	2·6	3·5

As far, therefore, as mere size goes, there is a very considerable difference between the molars of the two species, which appears to be pretty constant. The molars of both species agree in having trefoil-shaped discs of wear on one column

[1] Figures (of the natural size) of the molars of this species are given in Herr Vacek's Memoir on Mastodon. "Abhand der k. k. Geol. Reich.," Wien., vol. vii, pt. 4, 1877, plates IV, V.

[2] Plate XL, figs. 7—9.

of each ridge, but these trefoils are nearly always less distinct in the European teeth, and in some are very imperfect. In most of the teeth of *M. angustidens*, the accessory columns are more developed than in *M. falconeri*, and the valleys are consequently blocked to a greater extent. The second true molar of the former species carries a greater number of cusps on its ridges, and its talons are more complex than in the corresponding tooth of the latter. Again, the true molars of the European species generally diminish in width anteriorly to a greater extent than do those of the Indian species.

Comparing the tooth represented in fig. 8 of Plate XL of the "Fauna Antiqua Sivalensis," described as being the first upper true molar of *Mastodon angustidens*, but which is of the same size as the second true molar represented in the next figure, with the second upper true molar of *M. falconeri* described above, we find that the former tooth is somewhat longer than the latter, and is wider posteriorly and narrower anteriorly. The valleys in the European tooth are more blocked, owing to the greater development of the accessory columns; the latter being placed on the line of the median cleft, instead of on one side of it, as in *M. falconeri*. Again, the ridges of the molar of *M. angustidens* are considerably higher than are those of *M. falconeri*: thus, the height of the last ridge in the so-called first lower molar of the former species is 2·2 inches, whereas in the nearly equal-sized tooth of the latter it is only 1·4 inches. In an undoubted first lower true molar of *M. angustidens* in the collection of the Indian Museum, which is less than 3 inches in length, the height of the ridges is equal to the height of those of the corresponding tooth of *M. falconeri* with a length of 4·1 inches.

A second upper true molar of *Mastodon angustidens* represented in fig. 3 of Plate III of the second volume of the "Palæontological Memoirs," makes a nearer approach to the corresponding tooth of *M. falconeri* than does any other tooth that I have seen. The ridges on that tooth, however, are higher, the talons less developed, the accessory columns larger, and placed nearer the median cleft, than in *M. falconeri*. An excellent figure of what seems to be the first upper true molar of *M. angustidens* is given by H. von Meyer[1]: that specimen is a regularly oblong tooth, and has the columns of the ridges more distinct, and a deeper mesial cleft than in the last milk-molar of *M. falconeri* (Plate XXXII, fig. 3): the European tooth has a lateral cingulum continuous with the fore-and-aft talons, which is entirely wanting in the Indian tooth; in the latter the valleys are less open and more sinuous than in the former.

The presence of a cingulum in the upper molars of *M. angustidens* seems from von Meyer's figures to be very constant. The specimen of an apparently second upper true molar figured in the above quoted plate (fig. 7) of von Meyer's, has an almost complete cingulum, which is entirely wanting in the corresponding tooth of *M. falconeri* (Plate XXII, fig. 1): in the former tooth the valleys are less entirely open than in the latter: other teeth figured by von Meyer exhibit corresponding differences from those of *M. falconeri*, which the reader can examine for himself.

[1] Palæontographica, Vol. XVII, Plate III, fig. 1, (the lowest tooth in the figure).

Fine specimens of the associated penultimate and last lower true-molars of *M. angustidens* are figured by Herr. Vacek;[1] the penultimate molar there figured is a much smaller, narrower, and simpler tooth than the corresponding tooth of *M. falconeri* (Plate XXXIII, fig. 4); the valleys of the former are much more open, the accessory columns and the dentine trefoils less distinct than in the Indian tooth; the European tooth has a very small hind-talon. The mandible of *M. falconeri* has a sub-circular cross section, and a short symphysis, while that of *M. angustidens*[2] has the symphysis produced into a long rostrum; whether the former had tusks is not known; it seems almost certain, from the absence of any trace of premolars in the young cranium of the former species described above, that those teeth are not developed in *M. falconeri,* as they are in *M. angustidens.*

M. borsoni.—After *M. angustidens* no species of *Mastodon* comes very close to *M. falconeri* in the form of its molars. The molars of *M. borsoni* are at once distinguished from those of the Indian species by the almost complete absence of the median longitudinal cleft, which in general is only visible in germ or quite unworn specimens.[3] Figures of the teeth of this species are given in Messrs. Lortet and Chantre's monograph on the Mastodons of the Rhone basin.[4]

M. andium.—In *Mastodon andium*[5] the dentine discs of wear of the columns of the ridges are of nearly equal size, and do not form such distinct trefoils as in *M. falconeri.* The second lower molar in the former has no hind-talon, while the last lower molar has five ridges, which we have no reason to suppose was the case with *M. falconeri.*

M. humboldtii.—Fine specimens of the associated second and third lower true-molars of this species are figured by the late H. von Meyer.[6] The last tooth has four ridges and a very large hind talon, which might almost be classed as a fifth ridge. The penultimate lower molar has three ridges and a small hind talon: if the figure of this tooth be compared with that of the corresponding tooth of *M. falconeri* (Plate XXXIII, fig. 4), it will be seen that the European tooth irrespective of its smaller size, differs from the Indian by its much simpler structure, and smaller hind-talon; the columns in the former are not sub-divided into smaller cones, the accessory tubercles are small, and the valleys much more open than in the latter.

M. maximus.—In *Mastodon maximus* the ridges of the molars are relatively higher and narrower than in *M. falconeri;* the transverse valleys are completely open, and the hind-talon is very small.

[1] "Abhandl. der. k. k. Geol. Reich." Wien 18, Vol. VII, pt. 4, Plate IV, fig. 2.

[2] "Fauna Antiqua Sivalensis", Plate XLIV, fig. 5. Abhandl. der. schweiz, Pal. Gesell., Vol. III, Plate II, fig. 4.

[3] Falconer: "Palæontological Memoirs", Vol. II, p. 18.

[4] "Mastodontes du Bassin du Rhone." Archiv. du Mus. d'Hist. Nat. de Lyons, Vol. II, Plates XI, XII, XVI, XVI *bis.* Lyons, 1878.

[5] *M. andium* was originally classed by Falconer as a *Trilophodon,* though subsequently as a *Tetralophodon;* it appears in the latter group on page 14 of the second volume of the "Palæontological Memoirs," but a note is there appended, saying that Dr. Falconer thought of once again placing it among the *Trilophodons.* The species seems in reality to have been one forming a link between the two sections of the genus.

[6] "Palæontographica," Vol. XVII, Plate VI.

M. obscurus.—In *Mastodon obscurus* [1] the lower molars are relatively much narrower than are those of *M. falconeri.*

M. pandionis. Some of the molars of *Mastodon pandionis* are described in the succeeding pages, where their distinctness from those of *M. falconeri* will be pointed out.

Of *M. pentelici* [2] only the milk-molars appear to be known. The second and third upper milk-molars of that species are considerably larger than the corresponding teeth of *M. falconeri,* and there seems to be a greater number of accessory tubercles in the transverse valleys of the former teeth than in the latter. The second lower milk-molar in the Athenian species has a relatively larger talon than the corresponding Indian tooth; the two columns of the hinder ridge of the former tooth are moreover less closely connected than are those of the latter. Both these species seem to have had the common character of being unprovided with premolars.

M. productus.—The mandible of *M. productus* [3] is laterally compressed, and has a long tusked symphysis, and is, therefore, different from that of *M. falconeri.* The molars are also of simpler structure, and the columns of the ridges wear into irregular disks, and not into distinct trefoils of dentine.

M. pyrenaicus.—I cannot find any description of this species which seems to be only known from a manuscript note of the late E. Lartet.

M. tapiroides [4] is sufficiently distinguished from the present species by the fact that the transverse ridges of the molars are not distinctly bisected by a median longitudinal cleft, as well as by the transverse valleys being entirely uninterrupted by accessory tubercles. The early teeth of the species are figured by M. Gaudry [5] under the name of *M. turicensis;* M. Gaudry also seems to include *M. borsoni* under the same specific name, and there does not indeed appear to be any difference of specific value between the molars of the two. A fine series of the molars of this species are figured in Plates VIII and IX of the above-quoted memoir of Lortet and Chantre.

M. virgatidens.—Figures of three of the molars of this species are given in figures 1, 2, 4 of plate IV of the above quoted memoir of von Meyer. The teeth are quite unlike those of *M. falconeri,* as the ridges and valleys extend without interruption across the crown.

Since none of the *Trilophodons* with which I am acquainted agree in the characters of the teeth with the above described Indian trilophodont teeth, there seems to be no doubt as to the specific distinctness of the animal to which the latter belonged.

1 Leidy: "Extinct Vertebrate Fauna of the Western Territories," pl. 22.

2 Gaudry: "Animaux Fossiles et Géologie de l'Attique," Pls. XXII, XXIII.

3 Cope: "Extinct Vertebrata of New Mexico," United States Geographical Survey, west of 100th meridian, Vol. IV, pt. II, p, 306, Pls. LXX—LXXII.

4 Falconer: "Palæontological Memoirs" Vol I, p. 103

5 Gaudry: loc. cit. Plate XXIV.

Distribution.—Remains of this species have hitherto only been procured from the Siwaliks of the Punjab to the westward of the Jhelum river, and from the Manchars (Siwaliks) of Sind. No species of *Trilophodon* was known to Falconer and Cautley at the time of publication of the "Fauna Antiqua Sivalensis," whose main collections were obtained far to the eastward of the Jhelum (Sutledge and Ganges valleys), and from the vast series of mammalian remains collected by those writers it may be fairly inferred that the present species does not occur in the more easterly Siwaliks.

SPECIES 2: MASTODON PANDIONIS, Falconer. Plates XXXIV-V-VI-VII, fig. 3.

History.—This species was named by Dr. Falconer on the evidence of two molar teeth in the India House collection said to have been obtained from the Deccan. No description of the species was apparently ever published by Dr. Falconer, but in his synoptical table of *Mastodons* given on pages 14 and 15 of the second volume of the "Palæontological Memoirs," the species is classed by Dr. Falconer among the *Trilophodons*, in the division characterized by having molars with "*colliculi obtusi alternatim mammillati, valliculæ interruptæ.*"

Although no description of the molars of this species was ever published by Dr. Falconer, it appears that that writer made a comparison of these molars with certain of those of *Mastodon angustidens* in the collection of the late M. Edouard Lartet, the results of which comparison were embodied in a manuscript note. This note has been published on page 124 (*et seq.*) of the first volume of the "Palæontological Memoirs," but unfortunately in such a manner as to give the impression that the specimens in M. Lartet's collection belonged to the same species as the Indian teeth, though they really belonged to *M. angustidens.*[1] I have copied the note below, and have interpolated in brackets the name of the latter species where it is necessary to the proper comprehension of the text.

"No. 1.—The principal piece is a penultimate molar, upper jaw, left side; so determined from comparison with a germ specimen from M. Lartet of an antepenultimate (molar of *M. angustidens*). The crown of the tooth is perfectly entire, the front ridge alone being a little touched by wear on the inner side; but the fangs and base of the tooth are broken off right across on a line with the termination of the enamel shell. It exhibits three well defined ridges, with a thick strong front talon and a hind-talon confluent with the last ridge. It is a true and unmistakeable *Trilophodon*, the only one yet yielded by India, and very different in its crown characters from all the Siwalik, Ava, or other fossil *Mastodons* of the East.

"The general form of the crown resembles very strongly that of *Trilophodon angustidens*, the principal difference being that the 'col' of vallecular flanking mammillæ is still more developed than in that species. The crown is traversed, as

[1] The footnote on page 124 of the "Palæontological Memoirs" by Dr. Murchison, only adds to the confusion.

usual, by an indistinct longitudinal cleft along the axis, marking off an outer and inner division. Each of the three ridges has the outer division simple, and composed of a thick conical transverse mass, the summit of which is somewhat compressed and indistinctly bi- or tri-lobed by corresponding longitudinal furrows. The inner division is more massive and complex, each ridge throwing out from its anterior and posterior surface—the former diagonally forwards, the latter diagonally backwards—a 'col' of robust tubercles, which meet in a chevron form in the middle of the valley, so that, when the inner division of the crown is regarded in plan apart from the outer, it presents, in conjunction with the outlying tubercles, a series of zig-zags closely resembling the letter W. The complexity of pattern is further increased by the salient apex of the connecting 'col' being continued outwards towards the margin in a single line of cylindrical mammillæ, which completely obliterate the bottom of the outer half of each valley; while the inner half, corresponding with the re-entering angle between the large inner cones, forms a gorge which is entirely free from tubercles. The anterior talon forms a subordinate ridgelet, which is thrown off in the usual manner from the anterior portion of the inner cone, and is continued outwards towards the margin, with less inclination downwards than is usually the case in the other allied species (*M. angustidens.*) It is composed of about four robust compressed tubercles, which are separated from the anterior ridge by a well-marked chasm. The posterior talon consists of a cluster of indistinct confluent tubercles thrown off from the posterior part of the inner tubercle of the last ridge, and so adpressed to the ridge that it does not yield the defined and separate appearance seen in the talon of *Trilophodon angustidens.* After a little wear the posterior talon would be involved in the disc of detrition of the last ridge."

Dr. Falconer then proceeds to compare a small two-ridged tooth of *M. pandionis* with a corresponding tooth of *M. angustidens.* I shall have occasion to refer to this tooth again in the sequel.

Besides the two above-mentioned molars of *M. pandionis,* there is a left antepenultimate upper molar of the same species in the British Museum, represented on Plate XXXIV (figs. 6 and 7) of the first volume of the "Palæontological Memoirs," which was found in Dr. Falconer's private collection, the locality whence it was obtained being apparently unknown. Of this specimen I have obtained a cast for the Indian Museum through the courtesy of the Trustees of the British Museum.

A short note on some lower jaws of this species was published by myself in the "Records." [1]

Lower jaws and molars.—Having thus sketched the history of the known molars of *Mastodon pandionis,* I proceed to describe some lower jaws and molars of a trilophodont *Mastodon* collected by Mr. Theobald in the Siwaliks of the Punjab, and which I have referred to that species from the general resemblance of these molars to Falconer's original specimens.

[1] Rec. Geol. Surv. India, Vol. XII, p. 43.

The first specimens we have to consider are the two lower molars represented in Plate XXXIV. These two specimens are associated molars from the right ramus of an incomplete mandible collected by Mr. Theobald at Halwar in the Punjab. Since the smaller of the two teeth (fig. 1) carries three ridges and a hind-talon, while the larger and succeeding tooth (fig. 2) carries four ridges and a double hind-talon, or perhaps five ridges, it is evident that the two teeth are respectively the second and third true molars of a trilophodont *Mastodon.* The smaller tooth is in an intermediate state of wear, while the larger tooth has only its first and second ridges slightly touched by wear, the remaining three ridges having been still concealed by the gum at the death of the animal to which the jaw belonged. As I have said, the smaller tooth consists of three complete transverse ridges and a large hind-talon ; each of these ridges when not too much worn away, as is shown in the third ridge, is divided into an inner and an outer portion by a median longitudinal cleft. The summit of each of these two portions of the transverse ridges, when worn down, exhibits irregularly shaped discs of dentine, which never assume a trefoil figure, and by which character the molars of this species are at once distinguished from those of *Mastodon falconeri.* In the transverse valley between each pair of ridges, there are two or more accessory tubercles or columns, wedged in between the main ridges, completely blocking the valleys, almost as high up as the summits of the ridges, as is shown in the larger and less worn tooth. The inner and outer columns of each transverse ridge are placed somewhat alternately to one another, the centre of the inner column of each ridge being slightly in advance of the centre of the outer column. The hind-talon of the smaller tooth is of unusually large size, and, like the true ridges, consists of an inner and an outer column, separated by a median longitudinal cleft, and having two accessory columns in the preceding transverse valley. The talon is distinguished from a true ridge by being much narrower ; it is probable, however, that we have here (as in the succeeding tooth) a molar indicating the transition from a *Trilophodon* to a *Tetralophodon.* In the two anterior ridges of the penultimate tooth the exposed dentine discs of wear have united, but there is still in both a large trace of the median cleft.

The larger and nearly unworn tooth (fig. 2) shows the terminations of each column more distinctly ; but these columns have precisely the same arrangement as in the smaller tooth. There is an anterior talon consisting of four agglomerated columns, and a large double hind-talon.[1] The columns of the transverse ridges are of great vertical height, and at their summits curve towards the anterior extremity of the tooth. The valleys contain a considerable quantity of cement, which extends to within half an inch of the summits of the columns ; this cement appears to be loosely attached, and to fall off as the teeth are worn down. It, however, exists in all the specimens of unworn molars, which are contained in the collection of the

[1] The anterior part of this talon might almost be counted as fifth true ridge, but it will be seen to correspond with the hinder part of the smaller tooth, which is evidently a talon.

Indian Museum, and may therefore be considered as characteristic of the species. The dimensions of the two figured teeth are as follows:—

Length of second true molar	4·1
Width of ditto ditto	2·6
Length of third ditto	7·4
Width of ditto	3·0
Height of ridges in ditto	2·9

Comparison.—If the description of these two molars be compared with Falconer's description of the upper molar of *Mastodon pandionis*, and with the figure of the unworn upper molar, represented in figs. 6 & 7 of Plate XXXIV, of the first volume of the "Palæontological Memoirs," it will be evident that all these three teeth have the same general characters, *viz.*, very high and alternately arranged columns in the transverse ridges, and the transverse valleys completely blocked by outlying columns from these ridges. There appears, indeed, from Falconer's description, to be a somewhat greater complexity in the arrangement of the outlying columns in the upper molars than there is in the lower molars. All the other characters of the teeth are, however, so exactly similar, that there is every probability of their having belonged to the same species, and I have accordingly referred them all to *Mastodon pandionis.* The molar figured in the "Palæontological Memoirs," considered by Dr. Falconer to be the first or antepenultimate true molar, has a length of 4 and an extreme width of 2·5 inches; these dimensions are very nearly the same as those of the second or penultimate lower true molar from the Punjab; as will be seen subsequently, however, there is some considerable variation in the size of the molars of this species.

Form of mandible.—The portion of the mandible to which the two figured molars belong, comprehends the greater part of the horizontal ramus of either side; posteriorly each ramus is broken off at the hinder end of the alveolus of the last molar, and anteriorly a short distance in advance of the penultimate molar. The inner surface of the ramus is convex from above downwards, and the outer concave, the inferior border being slightly sinuous: the angle included between the inferior and alveolar borders is an acute one, the bounding lines receding from one another anteriorly, and the jaws consequently becoming deeper towards that extremity. The whole ramus is much compressed from side to side, the vertical diameter being much greater than the horizontal. The ramus is continued in the same line as the alveolar border up to the point where it has been broken off in front; at the fracture the depth of the sides of the mandible is close on 8 inches; the jaw presents in section at this point a U-shape, the base of the U being thick, and the sides very thin, and tapering to a sharp edge at their summits. The form of this transverse section, together with the direction of the upper and lower borders of the ramus, shows that the mandible when complete would have been produced into a long trough-like symphysis, and could not have had a short symphysis like that of the living Indian elephant. We shall subsequently describe a specimen showing this

trough-like symphysis. Where there is a short symphysis in Proboscidians, the alveolar border of the ramus descends suddenly in front of the anterior molar, as is well shown in Plates XLIV—V of the "Fauna Antiqua Sivalensis," and the transverse section near the commencement of the symphysis is sub-circular in each ramus, instead of having a thick base and a tall and slender side-wall. The mandible of *M. pandionis* presents two nervous foramina of unusually large size, the one situated immediately below the anterior border of the penultimate molar, and the other some 4 inches in advance, nearer to the inferior border of the ramus. The great size of these two foramina indicates a very large inferior branch of the fifth nerve, which would be necessary to supply the large amount of tissues investing a prolonged symphysial rostrum. The mandible has a vertical depth of 7·0 inches at the middle of the last molar, and of 7·8 inches at the commencement of the symphysis, its thickness at the same point being 4 inches. If these dimensions are compared with those of the mandible of *M. falconeri* given above, it will be seen that the form of the ramus of the mandible is alone an amply sufficient distinction between the two species.

Last lower molar.—The next specimens I wish to bring to notice, are the right lower molar, and the symphysis of a mandible, represented in fig. 4 of Plate XXXV and in fig. 1 of Plate XXXVI. The molar is implanted in a fragment of the right ramus of a mandible, which is a part of the same specimen as the symphysis. When first obtained in the Punjab, Mr. Theobald tells me that the whole mandible was complete; the specimen was, however, in an extremely friable condition, and when it arrived in Calcutta, the only portions which were not reduced to fragments were a part of the right ramus and the figured symphysis.

The figured tooth, which is about one-third worn down, carries four ridges and a large hind-talon. If this tooth be compared with the last lower molar represented in fig. 2 of Plate XXXIV, it will be seen (making allowance, of course, for the one tooth being well worn and the other a germ) that the two molars are similar in form, and evidently belong to the same species, both being in fact last right lower molars. It will not be necessary to describe the well-worn tooth, since I have mainly figured it in order to prove that the symphysis of the mandible associated with it really belonged to *Mastodon pandionis.*

The worn last molar is slightly larger than the corresponding unworn tooth, and the jaw in which the former is implanted is also correspondingly larger than the jaw which carries the unworn tooth; both jaws have, however, precisely the same form. In front of the worn last true molar, there remains in the jaw the fragmentary base of a smaller tooth, which from its size seems to have carried three ridges, and which would therefore correspond to the penultimate molar, represented in fig. 1 of Plate XXXIV. The length of the last molar is 8·4 inches, and its width 3·3 inches.

Symphysis of mandible.—The symphysis of the mandible, Plate XXXVI, fig. 1, consists of a long spout-like rostrum, the figured fragment being some 20 inches in

length. The medial line of this rostrum is deeply hollowed out posteriorly, the hollow gradually diminishing anteriorly; its depth posteriorly, where the specimen is broken off, is upwards of 7 inches, the lateral walls are thin, and nearly vertical externally. There are no traces of tusks in this specimen. There must have been an interval of at least a foot between the proximal extremity of this symphysis and the fragment of the ramus of the mandible where broken off in front of the penultimate molar.

Tusked symphysis.—We have now shown that *Mastodon pandionis* had a produced symphysial rostrum, which in some individuals was tuskless; this leads us to the consideration of another mandibular symphysis (Plate XXXVI, fig. 2), which from its form evidently belonged to a *Mastodon,* and I think most probably to *M. pandionis.* This specimen was, like the other, obtained by Mr. Theobald in the Punjab. It consists of the distal extremity of the symphysis, the fragment being about one foot in length. It is furnished with a pair of large and laterally compressed tusks, of which the middle portions alone remain. These tusks are strongly arcuated, their superior border being concave and their inferior convex: they consist entirely of ivory, and present no trace of any band of enamel, as seems to be universally the case in the genus. Their transverse diameter is 2 inches, and the vertical 3·1 inches. The rostrum itself is concave superiorly and convex inferiorly in the antero-posterior direction. The anterior portion of the superior surface presents a lozenge-shaped hollow, externally to which this surface slopes away to join the lateral surfaces. In this specimen there is no trace of the deep longitudinal groove which occurs in the tuskless symphysis represented in fig. 1 of the same plate. Such a groove could not, however, exist between the large tusks of the second symphysis, and if, as I think is most probably the case, the latter belonged to the same species as the former, it would seem that the presence of the large tusks, in the one and their absence in the other are the cause of the differences in form of the two specimens. The symphysis of the mandible is known in *Mastodon latidens, M. perimensis,* and *M. sivalensis,* as we shall see when we come to the description of those species, and the tusked symphysis cannot, therefore, belong to either of them, all of which have much shorter symphyses. The complete mandible of *M. falconeri* is unknown, but the specimen already referred to (Plate XXXIII, fig. 1) proves that this species had a short and probably edentulous symphysis. If, therefore, the tusked symphysis under consideration does not belong to *M. pandionis,* it must belong to a new species of Siwalik *Mastodon,* which is somewhat improbable. On the supposition that the symphysis in question belongs to *M. pandionis,* it must have belonged in all probability to a male individual, while the tuskless specimen represented in the other figure of the same plate must have probably belonged to a female.

Last upper true molar.—A last left upper true molar of a trilophodont *Mastodon* in the Indian Museum seems to belong to the present species. The specimen was collected by Mr. Theobald in the Punjab; but is not in a good condition for figuring

owing to the sandy matrix having become mingled with the enamel. The tooth is in germ, and has a convex crown surface, carrying four transverse ridges, and fore-and-aft talons. The anterior talon consists of a semi-circular ledge attached to the first ridge. The true ridges and the hind-talon correspond exactly in form with those of the corresponding lower molar represented in fig. 2 of Plate XXXIV: they are tall, placed somewhat alternately, and divided by a deep longitudinal cleft. The accessory tubercles appear to be arranged as in Falconer's specimens of the earlier upper molars; the valleys are completely blocked by outlying tubercles, and also contain a comparatively large quantity of cement. The length of the specimen is 7·7 inches, its greatest width 3·8 inches, and the height of the second ridge 3·3 inches.

First lower true molar.—The imperfect small tooth represented in fig. 1 of Plate XXXV is implanted in a fragment of the right ramus of a mandible, and, like the preceding specimens, was collected by Mr. Theobald in the Siwaliks of the Punjab. From its small size, this tooth must evidently be either the last milk-molar, or the first true molar, and from carrying only three transverse ridges, it must evidently belong to a trilophodont *Mastodon.* As the tooth is only slightly smaller than the second lower true molar represented in fig. 1 of Plate XXXIV, it is probable that it is the first true molar. The tooth is entirely unworn, and has lost the inner column of the first ridge. The posterior extremity of the specimen is slightly narrower than the anterior; and there seems to have been a very small anterior talon, judging from the fragment remaining on the outer column, and there is a very distinct hind-talon, of a much lower elevation than the third ridge. The ridges are all of great relative height, and are divided mesially by a cleft along the antero-posterior axis of the tooth; each ridge is slightly convex anteriorly, and concave posteriorly. From either side of the outer column of each ridge accessory columns or tubercles project into the transverse valleys, completely blocking them, nearly up to the summits of the ridges. Cement occurs in some quantity in the valleys. The length of this tooth is 4·2 inches, its greatest width 2·3 inches, and the height of the outer column of the first ridge 2 inches.

In being furnished with cement, as well as in the great relative height of the transverse ridges, this tooth agrees with the penultimate lower molar of *M. pandionis* represented in fig. 1 of Plate XXXIV. The accessory tubercles or columns are, however, less complex, and the ridges are placed less alternately than in the last lower molar represented in fig. 2 of the last-named plate. Now, we have already seen that the accessory columns are less developed in the second lower molar than in the upper molars, and it appears from the present specimen that these tubercles are still less developed in the earlier lower molars.

The present specimen is readily distinguished from the corresponding tooth of the other Indian *Trilophodon* (*M. falconeri*, Plate XXXIII, fig. 3) by its general shape, by the ridges being much higher (2 inches in place of 1·4 inches), by the valleys being blocked to a greater extent, and by the presence of cement.

Third lower milk-molar.—Of the third lower milk-molar there is a damaged specimen in the Indian Museum from Perim Island. This tooth carries three transverse ridges, and small fore-and-aft talons; it is narrower in front than behind, and in all essential characters it agrees with the preceding specimen. Its length is 3·4 inches, and its greatest width 2·3 inches.

? Second upper milk-molar.—The specimen represented in fig. 3 of Plate XXXV is evidently from its size a milk-molar or a premolar, while from its shape it as evidently belongs to the upper jaw. It carries two transverse ridges, a very small anterior talon, and a large posterior talon. From its carrying only two complete transverse ridges, it might be either the first milk-molar of a tetralophodont, or the second milk-molar of a trilophodont *Mastodon.* Now, from its size, the specimen is too large to be a first milk-molar, and must consequently be the second milk-molar of a *Trilophodon,* if it be not a premolar. Of the trilophodont Siwalik *Mastodon falconeri,* the second upper milk-molar is known (Plate XXXII, fig. 2), and there, therefore, only remains *M. pandionis* to which the specimen can belong; as we shall see immediately, its characters agree sufficiently well with those of the other teeth of that species to make it probable that the specimen is rightly referred to it.

The specimen was collected by Mr. Theobald in the Siwaliks of the Punjab, and is entirely untouched by wear, never having been protruded from the gum: we may, therefore, infer that the animal to which it belonged must have died in early infancy. The crown is considerably narrower in front than behind, and the ridges borne on it are of unusual relative height, the second being rather lower than the first. The latter, which is divided like the former, into an outer and an inner portion by the median longitudinal cleft which traverses the crown, has two large tubercles at either extremity: between these are two smaller ones—one on either side of the median cleft. The second ridge has two tubercles externally, and a mass of four small agglomerated tubercles internally. The larger size of this second mass of tubercles shows that this is the inner side of the tooth, which will consequently belong to the left side of the jaw. The hind-talon has two distinct tubercles externally, while internally it merges into an indistinct ledge on the second ridge. The main transverse valley is completely blocked up by an accessory column or tubercle, rising from the hinder side of the first ridge, and uniting at its base with one of the tubercles on the opposite side of the second ridge. A considerable quantity of cement occurs in this valley, at once distinguishing this tooth from those of all other Siwalik *Mastodons* except *M. perimensis.* The length of the tooth is 2·2 inches, its greatest width 1·8 inches, and the height of the first ridge 1·3 inches.

In the height of its ridges, their general form, as well as in the presence of cement, and in the blocking of the transverse valley, this tooth agrees with the first lower molar of *Mastodon pandionis,* and I accordingly provisionally refer it to the same species.

In fig. 1 of the fortieth plate of the "Fauna Antiqua Sivalensis," there is figured a tooth-germ which, except in being slightly smaller, agrees in all respects with the present specimen, and which is probably the corresponding tooth of the opposite side of the jaw. The description of the specimen as given by Falconer is as follows: "Figs. 1 and 1*a*.—*Mastodon latidens.* Second (?) upper milk-molar with two ridges. Length 1·9 inches, width 1·4 inches." Now, it is quite clear that the specimen cannot belong to *Mastodon latidens*, as the corresponding tooth of that species (Plate XXXVII, fig. 4) has three transverse ridges, which are very much lower, and the valleys are open and without cement. I shall again have occasion to refer to this question when I come to consider the second upper milk-molar of the latter species.

The present tooth has a considerable general resemblance to the corresponding tooth of *Mastodon angustidens*[1] (with which species *M. pandionis* seems to be closely allied), but is distinguished by the greater extent to which the transverse valley is blocked, and by the smaller size of the hind talon as well as by the generally larger size of the tooth.

Last lower premolar and second lower milk-molar.—The small specimen represented in fig. 2 of Plate XXXV is evidently either the second (penultimate) lower milk-molar, or the last lower premolar of a trilophodont *Mastodon;* it is similar to a tooth formerly in the possession of Falconer, and by him classed as the last lower premolar of *M. pandionis*, and is also very similar to the tooth generally classed as the last lower premolar of *M. angustidens*, from which I think that Falconer was probably right in referring his specimen to *M. pandionis.* As both the second milk-molar and the last premolar of *Trilophodons* have only two ridges it is extremely difficult to assign either of these teeth, when found isolated, to its proper serial position: I shall, however, show why I class the figured tooth as the latter. This tooth belongs to the left ramus of the mandible; its crown is elongated antero-posteriorly and is somewhat narrower in front than behind. This specimen, together with a slightly smaller but similarly shaped tooth, was obtained by Mr. W. T. Blanford in Sind. The smaller specimen shows very distinctly small discs of pressure on both the anterior and posterior surfaces, proving that the tooth when in position had another tooth on either side of it in close apposition: the figured tooth has only a disc of pressure posteriorly, showing that the preceding tooth must have dropped out at an early period. As the two teeth are precisely similar there cannot be the least doubt but that they are homologous.

This tooth, as we have seen, carries two complete transverse ridges, and small fore-and-aft talons, a wide and nearly open valley separating the two ridges. Both ridges are considerably worn, the plane of wear of the first being nearly horizontal, while that of the second is directed obliquely forwards. In the centre of the valley, between the two ridges, there is a small circular disc of dentine exposed, which is formed by the abrasion of one of the ridges of the corresponding upper tooth

[1] Gaudry: "Les Enchainements du Monde Animal," Mammifères Tertiaires, p. 180, fig. 239.

against the summit of a tubercle situated in this valley.[1] The first ridge is short, and has only a very faint trace of a median division; the second ridge is longer, and is distinctly divided into an outer and an inner column by a median cleft; each column of this ridge appears to have been capped by tubercles. The inner one of these two columns is placed somewhat in advance of the outer one. The worn tubercle in the transverse valley shows that the latter was somewhat blocked at its base; the transverse ridges are of considerable height.

The length of the tooth is 2·05 inches; its greatest width 1·5 inches; and the height of the worn front ridge 1 inch.

This tooth is of simpler construction than any of the other molars of *Mastodon pandionis;* we have, however, seen that in that species the lower molars are less complex than the upper, and the anterior lower teeth less complex than the succeeding ones. In describing the known teeth of *Mastodon pandionis* in the above quoted note in the "Palæontological Memoirs,"[2] Dr. Falconer describes a small tooth of that species in the following words :—"Among the teeth presented (to the India House) by Colonel Sykes, there is also a small two-ridged *Mastodon* tooth, with very smooth enamel, which in form, through every detail, agrees so exactly with a specimen (of a lower premolar of *Mastodon angustidens*) of Lartet's, that I unhesitatingly consider them to be homologous teeth of the same side and of nearly the same age.

Dimensions of premolar.	Lartet's.	Indian.
Extreme length	1·75	1·9
Width of front ridge	1·1	1·15
Ditto of back ridge	1·4	1·4

"Lartet's specimen is a detached tooth, labelled in his list, '*Last* lower *premolar*, left side.' It consists of two ridges, both of them worn; but the outer and inner discs not continuous, and the middle of the valley occupied by a tubercle, which is worn low down, leaving a circular disc. There is a well-marked anterior talon of two worn tubercles, but deeply impressed by an anterior disc of pressure against a preceding tooth in position. Behind there is also a talon, but very strongly impressed by a disc of pressure, so that the posterior talon only exists on the inner side. The crown presents the cucumber shape, so remarked on by De Blainville, *i.e.*, the first ridge is narrow (short), the second broad (long).

"The Indian fossil shows precisely the same characters, *i.e.*, two ridges worn, and two talons, with a connecting tubercle between the ridges. The back talon is marked with a disc of pressure, but the anterior talon consists of two confluent prominent tubercles, free from any mark, showing either that there was no *penultimate premolar*, or that it was very caducous and dropped out without pressure from behind. The anterior ridge is narrow (short); the posterior broad (long), as in Lartet's (specimen); but the ridges are more worn, and the discs confluent. The crown slopes from the inside, which is higher, to the outside, which is lower, but less

[1] This abraded spot is scarcely perceptible in the figure.
[2] Vol. I, p. 125.

so than in Lartet's (specimen). The intermediate tubercle is worn down as in his (specimen), and the posterior talon is only exhibited free on the inner side.

" The specimens are so exactly alike that they might have been taken for the same species, but that the Indian is a little larger."[1]

Now, a perusal of the foregoing note, will, I think, render it perfectly clear to the reader that the Indian tooth described therein is the corresponding tooth to our Sind specimen, and that consequently both teeth belong to the same species, which is probably *M. pandionis* of Falconer. With regard to the serial position of this tooth we find that according to Falconer it agrees exactly with a tooth in the possession of Ed. Lartet, and considered as the *last* lower premolar of *M. angustidens.* It also agrees with a similar tooth figured by von Meyer, in figures 12, 13 of plate V of Vol. XVII of the "Palæontographica," as the *second* lower premolar of that species; normally the number of premolars in Mastodons is two, and the last might therefore well be called the second. Von Meyer has, however, figured a specimen of a young upper jaw of *M. angustidens* (plate III, fig. 1), which he describes as containing two premolars, which he calls first and second, and a third tooth which he calls the third milk-molar. There can be no question but that the two first teeth in that specimen are premolars, since they are less worn than the third tooth. The posterior of the two premolars is a complex two-ridged tooth very like the second upper milk-molar of *M. falconeri;* according to von Meyer's classification this tooth must have succeeded a tooth (the second milk-molar) no more complex than itself, and a third premolar would have appeared above the third tooth in the jaw. As the second premolar in that jaw is as complex as the last premolar in the tetralophodont *M. latidens,* I cannot but think that the third tooth in von Meyer's jaw is really the first true molar, the jaw belonging to a very small animal. The second premolar will then be the last, and not the penultimate. If this view be admitted, the lower premolar, which he figures as the second or penultimate, will be the last, and indeed this must be so, because in a cast of a lower jaw of a young *M. angustidens* in the Indian Museum, we find that the premolar succeeding the last milk-molar is a two-ridged tooth, much like Meyer's specimen, while the preceding premolar has only a single column, and corresponds to the first (penultimate) premolar in Meyer's upper jaw. In this lower jaw the first true molar is no larger than the tooth which I consider the same in the upper jaw figured by Meyer.

The tooth of *M. angustidens,* which is so like our specimen, is therefore the last lower premolar, and I accordingly class the figured specimen as the corresponding tooth of *M. pandionis.*

I have, however, another reason why this tooth should be classed as the last premolar, and not as the second milk-molar. The small specimen represented in figure 3 of plate XXXVII, obtained by Mr. Fedden in Sind, from its narrow and elongated form, evidently belongs to the lower jaw, and seems to belong to a *Trilo-*

[1] The italics and brackets in the above note are my own.

phodon, being either the second milk-molar or the last premolar. The tooth belongs to the left ramus of the mandible, as is shown by the inner extremity of each of the two transverse ridges (top border of figure) being considerably higher than the outer; the first ridge is slightly smaller than the second, and there are small fore-and-aft-talons. The plane of detrition of the first ridge is directed obliquely backwards, and that of the second ridge obliquely forwards; each ridge is mesially bisected by a distinct antero-posterior cleft into an outer and an inner column. The length of this tooth is 1·6 inches and its greatest width 1·1 inches.

With regard to the position of the tooth and the species to which it belongs, I have but little doubt that the specimen belongs to a *Trilophodon*; of the two Indian *Trilophodons,* the second lower milk-molar of *M. falconeri* is known, and it is probable that there were no premolars developed in that species; there only remains, therefore, *M. pandionis.*

Of two specimens of the lower young dentition of *M. angustidens* in the Indian Museum, the one shows the last milk-molar, with the last premolar *in alveolo* below it, and the other the second and third milk-molars. In both these specimens the last milk-molar has a length of about $2\frac{1}{2}$ inches; the second milk-molar is 1·3 inches in length and the last premolar 1·8 inches. It is, therefore, apparent that in jaws having the last milk-molar of the same size, the last premolar is larger than the second milk-molar. On these grounds I have provisionally classed the tooth represented in figure 2 of plate XXXV (closely resembling the last lower premolar of *M. angustidens*) as the last lower premolar of *M. pandionis,* and the smaller tooth represented in figure 3 of plate XXXVII (closely resembling the second lower milk-molar of *M. angustidens*) as the second lower milk-molar of *M. pandionis.*[1]

The tooth classed as the second lower milk-molar of *M. pandionis* is small as compared with the second upper milk-molar of the same species figured in this memoir (Pl. XXXV, fig. 3). Falconer's specimen of the latter tooth referred to above, however, is smaller and agrees well in this respect with the lower tooth. The difference in size of the last lower premolars, shows the variations in size which the teeth of this species may undergo.

General characters.—Having now described such of the remains of *M. pandionis* accessible to me, as are of the most importance in illustrating its dentition and osteology, I proceed to summarize the general and distinctive characters of the species, as far as they are at present known. We are unfortunately totally unacquainted with the cranium, and nothing, therefore, can be said regarding this important part of the skeleton. The mandible is characterized by its compressed rami, and by being produced into an enormous symphysial rostrum, which in some individuals was tuskless, and in others (unless the symphysis figured in Plate XXXVI, fig. 2, belongs to a new species) carried large and much curved incisors.

[1] The specimen figured in figure 6 of plate V of the above-quoted memoir of Meyer as the second milk-molar of *M. angustidens* is a three-ridged tooth, and would therefore seem to be the third milk-molar.

With regard to the dentition, the molars, in regard to the number of ridges borne on their crowns, followed the normal trilophodont rule. The pattern of the molars approaches nearest to that of the molars of *M. angustidens*, but presents important differences which will be pointed out below. If the above identifications are correct, the species was provided with premolars.

Distinctions and differences.—From *Mastodon falconeri* (the only other Indian species with a trilophodont ridge formula to the molars), the present species is at once distinguished by its compressed mandible with its long symphysial rostrum. It is further distinguished by the more complex pattern of the crowns of the molars, and by the irregularly shaped discs, in place of the perfect trefoils of dentine, produced by the detrition of the ridges. The molars of *M. pandionis* are further, distinguished by the greater absolute height of the transverse ridges, and by the greater extent to which the intervening valleys are blocked by tubercles; there is also a greater tendency to an alternate arrangement of the columns of the ridges. Cement is present in *M. pandionis* and absent in *M. falconeri.*

Mastodon angustidens.—It is unfortunate that in the mandible of *M. pandionis* the portion connecting the alveolar part of the ramus with the symphysis is wanting, so that we are unable to institute a comparison between the complete mandible of *M. angustidens*[1] and *M. pandionis.* A very beautiful specimen of the extremity of the mandible of *M. angustidens,* is figured by Dr. Biederman :[2] that specimen carries two small sub-cylindrical tusks, and is greatly contracted laterally near the proximal end of the symphysis, proximately the rostrum has a deep trough, which expands into a flattened plate anteriorly. This symphysis is quite different in form from that of the tuskless symphysis of M. *pandionis* figured in figure 1 of Plate XXXVI: it approaches nearer to the tusked specimen in figure 2 of the same plate. There are, however, very considerable differences in the form of the trough and tusks, which are somewhat difficult to point out, but which will be very apparent if the two figures are compared together : the tusks in *M. pandionis* are much curved, the concavity looking upwards, and very highly compressed, while those of *M. angustidens* are quite straight,[3] and in the young individual, according to Falconer,[4] had a pyriform cross section. To the tuskless variety of *M. pandionis,* there is no corresponding form in *M. angustidens,* since in that species both sexes were alike furnished with inferior tusks;[5] the peculiar trough-like symphysis of the tuskless variety of *M. pandionis* has, therefore, no representative in *M. angustidens.* The two species resemble one another in the compressed rami and long symphysis of the mandible.

The molars of the Indian seem to be distinguished from those of the European species by their somewhat more complex pattern, and by the surfaces of dentine

[1] "Fauna Antiqua Sivalensis," Pl. XLIV, fig. 5.
[2] Abhandl. der. Schweiz. Pal. Gesell, Vol. III, pl. II, fig. 4—(Biederman's memoir).
[3] Von. Meyer : "Palæontographica," Vol. XVII, pl. VIII.
[4] "Palæontological Memoirs," Vol. II, p. 41.
[5] *Ibid.*, p. 12.

on the worn crown surface presenting irregularly, or somewhat triangular, in place of trefoil-shaped islets, as well as by the presence of large quantities of cement in the valleys. The second and third lower true molars of *Mastodon angustidens*[1] are much simpler teeth than the corresponding teeth of *M. pandionis* (Plates XXXIV, XXXV, fig. 4). In the latter the valleys are completely blocked by outlying tubercles whereas in the former they are tolerably open. There is a very small hind-talon in the penultimate molar of *M. angustidens*, and a very large one in that of *M. pandionis*: in the last molar of the latter species the hind talon is developed into a fifth ridge, whereas in *M. angustidens* there are generally only four ridges in the last molar, with a very small hind-talon: *M. pandionis* in these respects is evidently transitional between the *Trilophodons* and *Tetralophodons*. A penultimate lower true molar of *M. angustidens* figured by von Meyer[2] has a larger hind-talon than in the last mentioned specimen; this talon, however, is in the form of an elongated cingulum, and quite different from the two-coned talon of *M. pandionis*; the whole tooth of *M. angustidens* is of less complex structure than that of *M. pandionis*. That the two species are closely allied is, however, evident from the general structure of the molars and the mandible.

M. productus.—The mandible of the trilophodont *M. productus* of the Loup-fork group of New Mexico[3] has a produced tusked symphysis which has more resemblance to the tusked symphysis drawn in fig. 2, of Plate XXXVI of this memoir, and provisionally referred to *M. pandionis*. In *M. productus* (Plate LXX of Cope's memoir) the tusks are straight, and have their largest diameter in the transverse, and not in the vertical direction, in which respect they differ from the tusked mandible referred to *M. pandionis*. The molars of *M. productus* are smaller and of simpler structure than those of *M. pandionis*, and the last molar has only four ridges, without a hind-talon.

Mastodon pandionis does not approximate closely to any other described species of *Trilophodon* in its dental and mandibular characters.

Mastodon sivalensis.—Curiously enough the last lower molar of this species has a most remarkable resemblance to the corresponding tooth of the tetralophodont *Mastodon sivalensis*, as may be seen by comparing this tooth of *M. pandionis*, represented in fig. 4 of Plate XXXV, with the corresponding tooth of the same side of the jaw of *M. sivalensis* represented in fig. 3 of Plate XLIV. Both teeth appear to have the same number of ridges, though in the former the last ridge (from the characters afforded by the penultimate molar) is described as a talon, and in the latter (from the same considerations) as a true ridge. Both teeth agree in the general form of the ridges, of the columns, and of the accessory columns, and also in the general shape of the dentine islets: the main difference between the two teeth being that the molar of *M. sivalensis* is somewhat narrower than

[1] "Abhandl. der. k. k., Geol. Reich." Wien 1877, Vol. VII, Pt. 4, Plate IV, fig. 2.

[2] "Palæontographica", Vol. XVII, pl. IV, fig. 6.

[3] Cope: "Extinct Vertebrata of New Mexico," United States Geographical Survey, west of 100th meridian, Vol. IV, pt. II, p. 306, Pls. LXX—LXXII.

the other, and that the columns are rather more perpendicular in *M. pandionis.* The two teeth are, however, so alike that it appears to me to be extremely doubtful if they could be distinguished as belonging to separate species, if they had been found detached from the jaws. The tooth of *M. pandionis,* it will be remembered, is implanted in the ramus of the mandible with the long spout-like rostrum figured in Plate XXXVI, fig. 1, and as we find from other specimens, was preceded by a three-ridged tooth. The tooth of *M. sivalensis,* on the other hand, belongs to a nearly complete mandible with a short symphysis (described below), like that of the living Indian elephant, and was preceded by a four- (or occasionally five-) ridged tooth. There can, therefore, be no question as to the specific distinctness of the animals to which the teeth belonged. From this we learn that certain of the teeth of some species of Proboscidia may be almost indistinguishable from those of a totally distinct species, and from this it is not a very long step to the whole of the teeth in two species being of the same character, though the crania and mandibles are very distinct: this has an important bearing on the case of *Stegodon insignis* and *S. ganesa,* to be noticed below. I ought to add that the molar of *M. sivalensis* has no traces of the cement which occurs in that of *M. pandionis.*

Distribution.—Remains of *Mastodon pandionis* in the collection of the Indian Museum, have been obtained from the Siwaliks of the Western Punjab, Sind, and Perim Island: according to Dr. Falconer they have also been obtained from the Deccan, whence molars were sent by the late Colonel Sykes. As no remains of this species were obtained by Cautley and Falconer among their immense collections of fossils from the more easterly Siwaliks, it seems probable, as in the case of the last described species, that the geographical range of *M. pandionis* did not extend much to the eastward of the Jhelum river. The second milk-molar figured in the F. A. S. and referred above provisionally to this species, is an apparent exception; there is, however, no record of the locality whence that specimen came.

Section B.—Tetralophodon, Falconer.

Intermediate molars normally with four, but in some species occasionally with five transverse ridges.

Species 3: Mastodon latidens. Clift, (*in parte.*) Plates XXXVII, XXXVIII, & XXXIX.

History.—This species of tetralophodont *Mastodon* was originally named and described by the late Mr. Clift upon the evidence of certain molars brought from the valley of the upper Irawadi by the late Mr. Crawfurd early in the century.[1] These fossils appear to have been the first which were obtained by Europeans

[1] Trans. Geol. Soc. Lon., Ser. 2, Vol. II, p. 369.

from the mammaliferous strata of the Indian region. With the teeth which rightly belong to *Mastodon*, Mr. Clift appears to have included, under the same specific name, certain other molars with a higher ridge-formula, which really belonged to the sub-genus *Stegodon*, subsequently formed by Dr. Falconer. This error was detected and corrected by the late Dr. Falconer,[1] who described and figured other similar molars from the Indian Siwaliks[2] under the name of *Mastodon latidens*, at the same time clearly defining the characters of the species and the genus.[3] The distinctive characters of the molars of this species, as given by Dr. Falconer, are that the "intermediate molars" each carry four transverse ridges, which are low and blunt, and extend straight across the crown of the tooth. These ridges are separated by transverse valleys, which are quite open, and uninterrupted by outlying tubercles. Cement is virtually absent, or, at all events, is present in such small quantities that it may be practically disregarded.

In Plate XXXI of the "Fauna Antiqua Sivalensis" figures of more or less perfect specimens of the following teeth of this species have been given, namely, the third (?) upper milk-molar (fig. 2), the third upper milk and first true molar (fig. 3), the incomplete first and second upper true molars (fig. 4), and the last upper true molar (fig. 6). In Plate XL of the same work are given figures of the following teeth, namely, a tooth doubtfully considered as the second upper milk-molar (fig. 1), which, as we shall see below, does not belong to this species at all, the third upper milk-molar (fig. 2), and the first upper true molar (fig. 3). Excluding, therefore, the misnamed tooth, the upper molars of *Mastodon latidens*, known to Falconer and Cautley, were the third milk-molar and the three true molars; no complete specimen of the second true molar was, however, figured by them.

In the accompanying Plates XXXVII to XXXIX I have given figures of the three milk-molars,[4] of the second and third true molars, and of the penultimate and last upper premolars, so that, with a few exceptions, the whole of the dentition of this species is now known.

Distribution.—Before proceeding to describe the figured molars, I wish to say a few words relating to the distribution of this species. In the synoptical view of the species of *Mastodon* given by Dr. Falconer,[5] the distribution of *Mastodon latidens* is given as "Ava and Southern India;" this statement appears clearly to be erroneous. The real distribution of the species is as follows:—"Ava,[6] Siwaliks from Dehra-Dún to Punjab,[7] Sind,[8] and doubtfully from Perim Island.[9] The species,

[1] Pal. Mem., Vol. I, p. 59.

[2] Fauna Antiqua Sivalensis, Pls. XXXI and XL.

[3] Pal. Mem., Vol. II, pp. 11, 14.

[4] Except the first lower.

[5] Pal. Mem. Vol. II, p. 14.

[6] Clift : *sup. cit.*

[7] Specimens in Indian Museum.

[8] Falconer : Cat. of Vert. Foss. Mus. As. Soc. Bengal, p. 256. Ind. Mus.

[9] Falconer : *sup.* cit., p. 206.

therefore, has a wide range in space, though it is extremely doubtful if it was ever obtained from Southern India.

First upper milk-molar.—The small tooth represented in fig. 5 of Plate XXXVII is the first upper milk-molar of a tetralophodont *Mastodon*, as may at once be seen by a comparison of the specimen with the palate of a young *Mastodon longirostris* figured by the late Professor Kaup.[1] The first milk-molars of *Mastodons* are so alike, that it is a matter of extreme difficulty to refer them to their respective species. In the present instance there are, however, two points from the evidence of which the tooth may with a tolerable degree of certainty be referred to the present species.

The tooth belongs to the left side of the jaw, and is of a triangularly oval shape, narrower in front than behind; the crown bears two transverse ridges and an anterior talon or cingulum. The hinder ridge is divided into two distinct columns by a median cleft; the anterior ridge consists of a single thick and blunt cone. The enamel is thrown into a series of corrugations. The length of this tooth is 1·2 inches, its greatest width 1 inch, and the height of the hinder ridge ·6 inch.

In a note to Plate XL, fig. 1, of the "Fauna Antiqua Sivalensis," Dr. Falconer notices the left upper jaw of a young *M. latidens*, containing the first and second milk-molars. The first milk-molar has two ridges and a heel, and is oval-shaped. In having a heel or talon, the tooth of that specimen agrees with our figured specimen; the absence of a talon in another first upper milk-molar from the Siwaliks, which I have referred to *M. perimensis*, shows that that tooth cannot belong to *M. latidens*. The corrugated enamel is a character common to some of the later milk-molars of *M. latidens*, and does not occur in either *M. perimensis* or *M. sivalensis*. On these grounds I have referred the figured tooth to *M. latidens*.

In the Indian Museum there is another tooth similar to the figured specimen; both were obtained from the Punjab.

First lower milk-molar.—I cannot find any tooth in the Indian Museum which I can with any certainty consider as the first lower milk-molar of this species, neither is there any specimen figured in the "Fauna Antiqua Sivalensis."

Second upper milk-molar.—The next tooth for consideration is the specimen represented in fig. 4 of the last quoted plate, which was collected by Mr. Theobald in the Western Punjab. This tooth has its crown narrower in front than behind, and rudely oblong in form; it carries three transverse ridges, and fore-and-aft talons, the hinder one being somewhat broken. It presents a small disc of pressure anteriorly and a larger posteriorly, indicating the apposition of other contiguous teeth. The enamel is thrown into vertical corrugations. The ridges and valleys are perfectly straight and simple, the latter being entirely free from outlying tubercles; the ridges are very blunt and low, and are divided into outer and inner columns by a longitudinal cleft; the hindmost ridge is scarcely touched by wear. The middle ridge forms the highest point of the crown, showing that the tooth belongs to the

[1] "Ossements Fossiles du Muséum de Darmstadt," Pl. xvi, figs. 1, 1*a*.

upper jaw, while the state of attrition proves that it belongs to the right side. The characters of this tooth are so essentially those of *Mastodon latidens*, that there can be no hesitation in referring it to that species; from the number of ridges carried on the crown, the tooth must be the second or penultimate upper milk-molar. The length of this tooth is 2·05 inches; its greatest width 1·5 inches; and the height of the unworn ridge 0·7 inch.

This tooth being the second upper milk-molar of *M. latidens*, it is perfectly evident that the tooth, represented in fig. 1 of Plate XL of the "Fauna Antiqua Sivalensis," cannot belong to that species; that tooth has a semi-oval crown, and only carries two main transverse ridges, which are higher than in our specimen; it corresponds in form with the second upper milk-molar represented in Plate XXXV fig. 3, of this memoir, which I have provisionally referred to *M. pandionis*, to which species Falconer's specimen must likewise be referred. On page 51 of the Index to the Plates of the "Fauna Antiqua Sivalensis," Dr. Falconer makes a note to the effect that in the Museum of the Royal College of Surgeons, there is "the left side of the upper jaw of a young *Mastodon latidens* containing the first and second milk-molars. The anterior tooth is about 1 inch long and ·8 inch wide, and has two ridges with a heel. The main ridge is transverse; the anterior one is an obtuse cusp. The tooth is oval, the sharp end being in front. The second milk-molar is 2 inches long by about 1·5 inches wide. It has three main transverse ridges and a small bourrelet ridge in front, and a heel ridge behind. It expands very widely in the direction of the orbit. A vertical section shows something like the enamel of another small tooth half an inch long." From this note it will be clear that the specimen figured in the "Fauna Antiqua Sivalensis" as the second upper milk-molar of *Mastodon latidens* could not be that tooth if the specimen in the College of Surgeons were, because the one tooth had two ridges and the other three. The latter tooth, judging from Falconer's description, seems to agree exactly with the second upper milk-molar of *Mastodon latidens* figured in this memoir, and I have, therefore, no doubt but that the jaw in the College of Surgeons is rightly referred to that species. The first milk-molar in that jaw seems, as I have already said, to agree with the tooth referred above to the same serial position.

Second lower milk-molar.—In fig. 2 of plate XXXVII we have the corresponding lower tooth to the last specimen. This tooth was likewise obtained by Mr. Theobald in the Punjab. Its crown surface is concave superiorly, and as the ridges are most worn on the lower border of the figure, the tooth must have belonged to the right ramus of the mandible, while the presence of three transverse ridges and the small size of the crown prove the tooth to be the second, or penultimate milk-molar. The anterior part of the tooth has been somewhat damaged, the fore-talon being in consequence broken away. The posterior talon (left side of figure) is complete, and the two columns of which it is composed have their summits slightly touched by attrition; the three transverse ridges are all well worn. The tooth is narrower in front than behind; the ridges and valleys are low and

shallow; each ridge is slightly convex anteriorly, and there is also a slight tendency to a blocking of the transverse valleys by incipient accessory tubercles bulging out at the centres of the transverse ridges. This curvature of the transverse ridges and consequent partial obstruction of the valleys seems to be a character which distinguishes the lower from the upper molars of *Mastodon latidens*. This character is well exhibited in the specimen under consideration, in the succeeding lower milk-molar represented in fig. 1 of the same plate, in the lower true molar represented in fig. 8 of Plate XXXI of the "Fauna Antiqua Sivalensis," and in all the lower molars of this species contained in the Indian Museum. The enamel is quite smooth. The length of the second lower milk-molar (allowing a quarter of an inch for the broken talon) is 2·3 inches; and its greatest width 1·7 inches. The tooth is, therefore, slightly larger than the second upper milk-molar: a slight increase of size in the lower over the upper molars seems to be of very general occurrence in the *Mastodons*.

Third upper milk-molar.—Continuing our serial description of the molars, the next tooth we have to consider is the third or last upper milk-molar, of which a specimen is represented in fig. 8 of Plate XXXVII. This tooth is the specimen referred to on page 72 of the eleventh volume of the "Records of the Geological Survey of India," in connection with the presence of premolars in this species. The tooth was obtained by Mr. Theobald in the North-Western Punjab, and is implanted in a fragment of the left maxilla; above this tooth there was found in the bone the germ of a smaller premolar tooth (represented in fig. 6 of the same plate), which would subsequently have displaced the larger tooth vertically, had the animal lived long enough. The presence of this premolar above the larger and more complex tooth proves that the latter belongs to the milk-molar series, and the presence of four ridges on that tooth shows that it must be the last of that series, or the first of the "intermediate" molars of Dr. Falconer's arrangement. The tooth has an oblong crown, slightly narrower in front than behind: the three first ridges are well worn, and their dentine disks have become partly united: the last ridge is somewhat worn on the inner side, and very slightly on the outer, while the posterior talon is almost intact. In profile the crown is strongly convex. The anterior talon, judging from the width of the first dentine surface, must have been small, while the posterior talon is of relatively large size and is double. The transverse ridges are very low and blunt, and extend almost straight across the tooth; the valleys are open and entirely unobstructed by accessory tubercles. As is seen in the slightly worn last ridge, there is a longitudinal cleft, placed slightly on the outer side of the median line of the tooth, and dividing each ridge into an inner and an outer column, of which the inner is considerably the larger. In respect of this longitudinal cleft, and indeed in all characters (except of course size and the number of ridges), the tooth agrees precisely with the smaller second upper milk-molar represented in fig. 4 of the same plate. The enamel is corrugated. The length of the last milk-molar is 3·7 inches, and its greatest width 2·2 inches.

In fig. 2 of Plate XL of the "Fauna Antiqua Sivalensis," there is represented a small upper tetralophodont tooth of *Mastodon latidens*, which is doubtfully described as the third milk-molar. That tooth, though unfortunately represented on a very small scale, seems to correspond in every particular with the third upper milk-molar described above (in comparing these teeth, allowance must of course be made for the fact that our specimen is much worn, while Falconer's is an unworn germ), and I have no doubt but that they are the corresponding teeth. Falconer's specimen is, however, somewhat smaller than Mr. Theobald's, which may very probably be accounted for by the one tooth having belonged to a female and the other to a male individual. The length of Falconer's specimen is 3 inches, and its width 1·8 inches.

In figs. 3 and 3*a* of Plate XXXI of the "Fauna Antiqua Sivalensis," there is represented a fragment of the right maxilla of a young individual of *M. latidens* containing two teeth, which were doubtfully considered by Dr. Falconer as being the third milk-molar and the first true molar. The most anterior of these teeth (remembering that the two specimens belong to opposite sides of the jaw) will be found to agree very closely in all respects with the third upper milk-molar from the Punjab, described above; the only difference between the two being that the hind-talon is rather less developed in Falconer's specimen. The length of the latter specimen is 3·7 inches, and its width 2·6 inches. This length agrees precisely with that of our Punjab specimen, but Falconer's specimen is rather the wider of the two. There seems, however, to be no doubt but that the two teeth correspond in relative position.

Third lower milk-molar.—Of the third lower milk-molar, a nearly perfect specimen is represented in fig. 1 of Plate XXXVII. This specimen was formerly in the collection of the Asiatic Society of Bengal, and was from thence transferred to the collection of the Indian Museum; it is described by Dr. Falconer at page 206 of the Catalogue of the Fossil Vertebrata in the Museum of the Asiatic Society. It is uncertain whence this tooth came, but Ava seems to be the most probable locality. The tooth is implanted in a fragment of the right ramus of the mandible; in front of this tooth there is the remnant of a smaller tooth; the jaw is very small and narrow. In describing this specimen, Dr. Falconer considered it as being probably the first true molar, but the jaw is much too small to have carried three teeth in front of this tooth, while the proportion of this tooth to the last upper milk-molar represented in fig. 8 of Plate XXXVII is very much the same as exists between the lower and upper second milk-molars represented in figs. 2 and 4. I, therefore, think it probable that the specimen represented in fig. 1 is really the third lower milk-molar of *Mastodon latidens*, and I shall accordingly so consider it. The anterior ridge and talon are a good deal damaged, but the tooth when complete carried four transverse ridges and a large hind-talon. The characters of the tooth are so essentially those of the second lower milk-molar represented in fig. 2 of the same plate that no further description is necessary. The length of the tooth is 4·1 inches, and its greatest width 2·2 inches.

First upper true molar.—Of the first upper true molar, we have no complete specimen in the collection of the Indian Museum. A tooth is, however, represented in figs. 3 and 3*a* of Plate XL of the "Fauna Antiqua Sivalensis," considered by Falconer to be the first true molar, and which I also think is so, as it is considerably larger than the third milk-molar represented in figs. 2 and 2*a* of the same plate of that work. The length of the first upper true molar is 4 inches, and its width 2·3 inches. The length of this tooth, it will be observed, is not much in excess of that of the third upper milk-molar from the Punjab described above, and it is probable that Falconer's first true molar, like the last milk-molar figured on the same plate, belonged to a female individual. The first true molar carries four ridges and two talons, and agrees in all essential characters with the upper milk-molars described above. We have already referred to the fragment of the maxilla of *M. latidens* which is represented in figs. 3 and 3*a* of Plate XXXI of the "Fauna Antiqua Sivalensis," and have shown that the first of the two teeth contained in that specimen is in all probability the last milk-molar. The succeeding tooth in that specimen must consequently be the first true molar. This tooth is quite different from the last-mentioned first true molar; it differs from that tooth in being larger, and, in place of carrying only four transverse ridges, carries five distinct transverse ridges and two talons; the tooth narrows behind, and has the general form of a last, in place of a first, true molar. The length of this tooth is 5·6 inches, and its greatest width 2·9 inches. In regard to width, therefore, this tooth has a relative size corresponding to that of the last upper milk-molar represented in fig. 8 of Plate XXXVII of this memoir, and probably belonged to a male animal. The additional ridge, and the great size of the hind-talon of the first true molar represented in the "Fauna Antiqua Sivalensis," can only be looked upon as abnormalities. We shall see presently that a corresponding abnormality occasionally shows itself in the succeeding molars of this species.

First lower true molar.—Of the first lower true molar of *Mastodon latidens* there is no complete specimen either in the collection of the Indian Museum or among the teeth figured in the "Fauna Antiqua Sivalensis."

Second upper true molar.—The large molar represented in fig. 2 of Plate XXXVIII belongs to a splendid specimen of the palate of *Mastodon latidens* obtained from a Burmese Pagoda by Sir Arthur Phayre, and by him presented to the Museum of the Indian Geological Survey (now Indian Museum). This palate contains the second true molar of either side (of which the right is figured), and the first ridge of each of the last true molars. The molars in this palate, as well as in another splendid specimen, with the corresponding teeth, in the Indian Museum, collected by Mr. Theobald in the Punjab, converge anteriorly to a greater extent than occurs in any other species of the genus, and present in this respect a similar relation to that which we find prevailing in the *Stegodons* and true elephants. The figured tooth is in a medium state of wear, the hind-talon being still scarcely touched. There is a small anterior talon and a very large posterior talon, the latter indeed

almost assuming the proportions of a fifth ridge. Each ridge is very low and blunt and closely approximated to the adjoining ridges. A longitudinal cleft, placed slightly on the outer side of the median line of the tooth, divides each transverse ridge into an inner and an outer column, each of which is again sub-divided into smaller mammillæ or cusps, of which there are generally two on the outer, and four on the inner column. The transverse valleys are perfectly uninterrupted, except at the inner extremities of the third and fourth, where there are low and blunt tubercles. There are semi-distinct tubercles on the hinder side of the latter ridges. The tooth agrees in all essential characters with the milk-molars already described.

In the first column of the following table are given the dimensions of the palate to which the figured tooth belongs, while in the second column are given those of the somewhat larger but very similar palate referred to above:—

Interval between outer surfaces of posterior extremeties of second molars . .	10·0	11·0
Ditto ditto of anterior ditto ditto . .	8·0	9·0
Ditto inner surfaces of posterior extremeties of second molars . .	3·4	4·0
Ditto ditto of anterior ditto ditto . .	1·5	2·4
Length of second molar	6·6	6·3
Greatest width of second molar	3·6	4·0
Width of first ridge of third molar	4·1	4·3

The second upper molar in the larger palate differs from the figured specimen of the same tooth, in that its posterior talon is of very small size, and makes no approach to a fifth ridge. In fig. 1 of Plate XXXVIII an imperfect second upper molar of *M. latidens* is represented, which in the form of its ridges and valleys will be seen to correspond precisely with the second upper molar represented in fig. 2 of the same plate. Both teeth are from the right side of the upper jaw, and both are very evidently in the same state of detrition. The imperfect tooth, which was collected by Mr. Theobald in the Punjab, has lost a part of its first ridge and anterior talon, and also a portion of the inner extremeties of the second and third ridges. This tooth is of slightly smaller size than the complete specimen, but is doubtless the corresponding tooth. In describing the perfect tooth represented in fig. 2, it was noticed that there might be some question in deciding whether that tooth had five ridges, or four ridges and a large hind-talon. The imperfect tooth has, however, most distinctly five ridges, though the fifth is somewhat smaller and lower than the others: at the back of this fifth ridge there is a very small hind-talon. Now, there can be no doubt but that this fifth ridge is the representative of the talon of the more perfect tooth (fig. 2), and we have, therefore, established the important fact that in the second upper molar of this species there is a complete transition from a four-ridged to a five-ridged tooth.

Second lower true molar.—Of the second lower true molar there are several specimens in the collection of the Indian Museum. In their general characters these teeth are merely enlarged repetitions of the lower milk-molars represented in figs. 1 and 2 of Plate XXXVII, and I have not, therefore, thought it necessary to give figures of any of them. Some of these teeth carry four transverse ridges

with a large hind-talon, others five ridges, and others again five ridges and a large hind-talon, so that these teeth present modifications, in this respect very similar to those which we have found to prevail in the corresponding upper teeth. The length of a tetralophodont second lower true molar in the Indian Museum is 6·8 inches, and its width 3·6 inches.

Third upper true molar.—The large tooth represented in Plate XXXIX is a specimen of the last upper molar of the right side of *M. latidens*, collected by Mr. A. B. Wynne near the village of Lehri, in the Punjab. This specimen is implanted in a fragment of the maxilla, which also contains the two last ridges of the preceding or penultimate tooth. The figured tooth is entirely unworn, and was still covered by the gum at the death of the animal. The crown carries six transverse ridges, the hindmost of which is considerably smaller than the others, and probably represents an ultra-developed talon, as we saw to be the case in the penultimate molar represented in fig. 1 of Plate XXXVIII. The tooth consequently belongs to a "pentalophodont" type of dentition. The ridges are low and simple, and with the exception of the first, are slightly convex anteriorly, and as concave posteriorly. Each ridge is divided by a longitudinal cleft placed somewhat externally to the mesial antero-posterior axis of the tooth. The internal moiety of each ridge, with the exception of the second and sixth, bears three mammillæ or cusps, while the external moiety bears only two on each ridge. The valleys are quite simple and uninterrupted. In this tooth, as also in all the previously described specimens, there is no trace of cement. The length of the specimen is 8·6 inches, and its greatest width 4·2 inches. The last upper molar of this species represented in fig. 6 of Plate XXXI of the "Fauna Antiqua Sivalensis" has the normal five ridges of the tetralophodont type, and there is a similar specimen in the Indian Museum. This tooth may, therefore, be either penta or hexalophodont.

Third lower true molar.—I have not yet seen any complete specimen of the third lower true molar of this species. An imperfect specimen, in the collection of the Indian Museum, from the Punjab, has four ridges remaining, the first of which has a width of 4·1 inches.

Premolars.—In figs. 6, and 7 of Plate XXXVII are represented two small teeth which are probably both premolars, and one of which (fig. 6) certainly belongs to *M. latidens.* I cannot be sure whether the other specimen is rightly referred to the present species, and I may add that it is often a matter of extreme difficulty to refer these small isolated teeth to their respective species and serial position, when we have a large number of species to deal with.

Last upper premolar.—With regard to the tooth represented in fig. 6, no difficulty presents itself, since this tooth is a germ which was embedded in the bone above the base of the last left upper milk-molar represented in fig. 8 of the same plate, and which must consequently be the last upper premolar of the same side. The crown of this germ has its angles rounded off, and carries two

equal-sized transverse ridges, and a smaller row of cusps representing a third ridge posteriorly. The two main ridges are divided by a median cleft, and are low and straight, and the valleys are open and uninterrupted. The length of this tooth is 2·2 inches, and its greatest width 1·8 inches. Two very similar, but worn specimens, of the same tooth are contained in the collection of the Indian Museum. This tooth is of great importance as proving the existence of premolars in the species. Since this tooth is so much smaller than the tooth which it succeeds (Plate XXXVII, fig. 8), it is quite clear that when protruded, it could not have touched the teeth on either side of it, and probably stood quite isolated, as the corresponding tooth of *M. perimensis* represented in Plate XL.

Penultimate upper premolar.—The next specimen (Plate XXXVII, fig. 7) was also obtained from the Punjab. This tooth has no disc of pressure on either side; from its form it might be either the first upper milk-molar or the penultimate premolar of a *Tetralophodon,* or the second upper milk-molar or last premolar of a *Trilophodon.* The absence of any disc of pressure in front shows that it cannot be the second milk-molar of a *Trilophodon,* while its large size and absence of posterior disc of pressure shows that it cannot be the first milk-molar of a *Tetralophodon.* Among the *Tetralophodons, M. latidens* and *M. perimensis* are known to have been furnished with premolars, and it is, therefore, very probable that the tooth is the penultimate upper premolar of one of those species. As the tooth has low ridges, I have thought it not improbable that it belongs to the former species, though I cannot be at all positive in this determination. The tooth is considerably worn down, and has an irregularly oval-shaped crown, somewhat narrower in front than behind. It carries two low and broad ridges, closely approximated externally, and a small hind-talon. The side of the ridges on the lower border of the figure is the most worn, showing that this border is the inner side of the tooth, which must consequently belong to the right side of the maxilla. The transverse valley is not very distinct, which might lead to the belief that the tooth does not belong to *M. latidens.* Premolars, however, not unfrequently vary somewhat from the type of the other teeth. The length of the specimen is 1·6 inches, and its greatest width 1·4. Another very similar specimen, also from the Punjab, is in the collection of the Indian Museum.

General characters.—Having now passed in review the molar series of *M. latidens,* we may sum up what is known regarding the species. The adult cranium is unfortunately quite unknown; the palate is noticeable from the extent to which the molars converge anteriorly. The mandible is known by a specimen of the greater part of the right ramus, containing the two last molars, in the collection of the Indian Museum. This mandible is very long and slender, and sub-circular in cross-section, in the middle its vertical diameter at the penultimate molar being 5·8 inches and its transverse diameter 5·6. inches. The lower border is nearly straight up to the symphysis, with a slight convexity in the middle. From the extremely small size and circular section of the ramus where broken off at the commencement of the symphysis, the latter must have been short, and was probably unprovided with incisors.

The ridge formula of the milk-molars is constant, and conforms to the normal tetralophodont order; in the true molars, however, there is not an unfrequent tendency to assume a pentalophodont type, the hind-talon of many of these teeth not unfrequently, partly or entirely, taking the form of a fifth ridge. In the following ridge-formula these varieties are indicated :—

Milk-molars.	True molars.
$\frac{2 + 3 + 4}{2 + 3 + 4}$	$\frac{(4-5) + (4-5) + (5-6)}{4 + (4-5) + 5}$

This tendency to the production of an additional ridge in the true molars of *M. latidens* will be subsequently shown to be a character which it possesses in common with *M. sivalensis.* This tendency to variation enables us easily to comprehend how the passage from the tetralophodont *Mastodons* to the hexalophodont *Stegodons* (*S. cliftii*) was effected. A similar tendency to variation in the ridge formula of various species of European *Mastodons* is noticed by M. Gaudry.[1] With these very important variations in the molars, which, as in *M. latidens,* can be traced gradually from an incipient to a perfect ridge, it seems impossible that any naturalist can continue to maintain that there is at present no evidence of the passage of one species of animal into another. If the very small hind-talon of the five-ridged second upper molar of *Mastodon latidens* described above (Plate XXXVIII, fig. 1) were to develope into a true ridge, as we have seen to be the case with the talon in the four-ridged tooth (*ibid.* fig. 2), and were the median cleft to disappear and a little cement to appear in the valleys, the hypothetical six-ridged tooth would then be almost, if not quite, indistinguishable from the corresponding tooth of *Stegodon cliftii.* Such considerations appear to me to make it very doubtful whether the genus *Stegodon* should not be abolished and united with *Mastodon.* But here a new difficulty presents itself, since the genus *Stegodon* at one end presents elephantine characters in its molars, and at the other mastodontine. Thus *S. cliftii* (including *S. sinensis*) has the inner side of the upper molars the lowest, as in the *Mastodons,* while all the other *Stegodons* have the centre of each ridge the highest, as in the *Loxodons* and true Elephants. On the other hand, all the *Stegodons* have the elephantine character of having generally no median cleft to the molars, but this is a character which is equally shared with *Mastodon borsoni* and some other species of that genus. On the other hand again, the molars of *Stegodon insignis* are very close in general structure to those of *Loxodon planifrons,* and are certainly nearer to those of the true Elephants, than to those of the *Mastodons.* *Stegodon insignis,* however, cannot be generically separated from *S. cliftii,* and we are therefore led to the conclusion that if the latter species were united to the *Mastodons,* then the latter would have to be classed in the same genus as the true Elephants. There is, indeed, no real distinction between Elephants and *Mastodons,* although the species at either of the chain (*Mastodon maximus* and *Euelephas primigenius*) are widely separated from

[1] "Les Enchainements du Monde Animal." Mammifères Tertiaires, p. 181, Paris, 1878.

each other. Premolars are common to some *Mastodons* and one *Loxodon* (*L. planifrons*); cement is found in the valleys of the molars of *M. pandionis*, *M. humboldtii*, and *M. perimensis*, and we have already referred to the mesial cleft and plane of wear of the molars in *Mastodon* and *Stegodon*. At present, it is true, there is no *Mastodon* known which carries more than five ridges in the intermediate molars, but *Stegodon cliftii* has but six, and is therefore merely the next step in the ascending scale towards the true Elephants. The only other point in the dentition of *Mastodons* in which they differ entirely from Elephants, is in the presence of lower incisors, but this is only a character possessed by some species of the genus. It appears, therefore, that there is no definition by which all *Mastodons* can be distinguished from all *Stegodons* and the other Elephants; and although it may be desirable to retain these generic (or sub-generic) terms as convenient landmarks in the evolutionary series from *Mastodon* to Elephant, I cannot but think that they cannot be philosophically justified, and that all the known Proboscidians, with the exception of *Dinotherium*, ought to be classed in one large genus.[1]

The line of descent of the true elephants from the *Dinotheria* has evidently gone through some form allied to a *Trilophodon* of the type of *M. maximus*, then through a tetralophodont form like *M. latidens*, then through the *Mastodon*-like *Stegodons*, like *S. cliftii* and *bombifrons*, then the higher-ridged *Stegodons*, like *S. insignis*, and finally, through the *Loxodons*. The trilophodont and tetralophodont *Mastodons*, with alternately arranged columns, like *M. angustidens* and *M. sivalensis*, belong to a group which seems never to have been further modified in the direction of a more complex ridge formula than a pentalophodont type in the true molars.

It will be noticed in the above descriptions that all the upper milk-molars of *M. latidens* have corrugated enamel, while the lower have the enamel smooth and polished. As I have at present only seen one specimen of each tooth (excepting the first upper milk-molar), I am unable to say whether this is a constant peculiarity, or whether, as is perhaps more probable, there be two varieties of the species, in one of which the enamel is smooth and in the other polished.

Distinctions and differences.—*Mastodon latidens* does not seem to come close to any other species of the genus, the nearest approach being made, in regard to the characters of the molars by the European *M. longirostris*. The molars of the latter species, however, have much taller ridges, with a deeper median cleft, and with accessory columns partly blocking the bases of the valleys: the series of molars on either side of the palate in *M. longirostris* do not incline together anteriorly to the extent they do in *M. latidens*. The two species are further widely distinguished by the form of the mandible, that of the Indian species being nearly straight inferiorly, subcircular in section, with a short and probably tuskless symphysis, while that of the

[1] On page 12 of a paper on the "Extinct Animals of North America," read before the Royal Institution on March 10th, 1876, by Professor Flower, the author remarks that "*Mastodons*, however, were, after all, very like Elephants, only being distinguished by some peculiarities of the teeth; and by means of intermediate species the two forms pass so gradually into one another, that it is difficult to say, in the case of some species, with which they ought most properly to be classed."

European species is laterally compressed, has a long tusked symphysis, and its inferior border bends suddenly upwards below the first molar. (F. A. S., Pl. XLV, fig. 10).

Species 4: Mastodon perimensis, Falconer and Cautley. Pls. XL, XLI, figs. 1, 3, 4, XLII, XLIII.

History and specific characters.—The remains of a species of *Mastodon* obtained from Perim Island were referred by the authors of the "Fauna Antiqua Sivalensis" to a new species, under the name of *Mastodon perimensis,* and figures of the cranium and of some of the molars are given in Plates XXXI, XXXVIII, XXXIX, and XL of that work, though no detailed description of the species was ever published. Various notes, however, on the teeth of this species will be found scattered through Dr. Falconer's papers, as collected in the "Palæontological Memoirs," and figures of two molars are given on Plate IX of the first volume of that work. In the synopsis of the species of *Mastodon* and Elephant given on pages 14 and 15 of the second volume of the "Palæontological Memoirs," *Mastodon perimensis* is classed among the *Tetralophodons* which have the columns of the transverse ridges arranged alternately, and the intervening valleys blocked; while on page 12 of the same volume, we find it stated by Dr. Falconer that the molars of this species have a considerable quantity of cement in the valleys. The figures of the molars in the "Fauna Antiqua Sivalensis" show that they are characterized by the valleys being mainly transverse, but blocked in the middle by accessory columns, while one of the columns of each of the transverse ridges, when worn, presents a rudely trefoil-shaped dentine surface. In the "Records of the Geological Survey of India,"[1] I have mentioned the discovery of a mandible of this species in the Punjab, and have also shown that the species was provided with upper premolars, and that the male was provided with small cylindrical mandibular incisors. The teeth figured in the "Fauna Antiqua Sivalensis" are in most instances more or less imperfect specimens, as is so very frequently the case with fossils from Perim Island, which have usually been subjected to a long course of washing and rolling on the sea-beach. The teeth of *M. perimensis* collected by Mr. Theobald in the Siwaliks of the Punjab, which form the subject of the present notice, are in far more perfect condition. The milk-molars of this species are unfortunately at present, with one exception, unknown, but specimens have been obtained of the whole of the series of true molars, and one specimen of the last upper premolar is known. In describing these teeth I shall take them in the order of their serial succession.

First upper milk-molar.—The small tooth represented in fig. 3 of Plate XLI was obtained by Mr. Theobald in the Siwaliks of the Punjab. From its size and shape, it is evidently the first upper milk-molar of a *Mastodon,* and from the distinctness of the two ridges, in all probability of a tetralophodont species; from the

[1] Vol. XI, p. 71; Vol. XII, p. 45.

extreme smoothness and polished state of the enamel, I have thought that the specimen should very probably be referred to *Mastodon perimensis*, the teeth of which present that character to a very noticeable extent. The tooth belongs to the right side of the jaw, and is rudely oval in outline, the posterior border, however, being nearly straight. The crown bears two ridges, the hindmost of which is acute and wedge-shaped, and is partially divided by a slight cleft into two columns. The anterior ridge forms a large blunt cone, the summit of which has been largely worn away. A longitudinal ridge on the inner side of the tooth connects the fore-and-aft ridges; there is no trace of any talon. The absence of any talon, as well as the shape of the ridges, at once distinguishes this tooth from the corresponding milk-molar of *Mastodon latidens,* which has already been described. The length of the specimen is 1·3 inches, and its greatest width 1·1 inches.

Last upper premolar and first true molar.—The fragment of the left maxilla of a *Mastodon* containing two teeth, which is represented in Plate XL, was also obtained during the winter of 1878 by Mr. Theobald in the Siwaliks of the Punjab, and has already been shortly alluded to at page 45 of the twelfth volume of the "Records." The larger tooth carries four transverse ridges on the crown, and very small fore-and-aft talons: the fourth ridge is smaller than either of the others, and is considerably curved. The tooth has not been much used, and the rate of wear is very unequal on the two sides of each ridge, the inner column showing a large surface of dentine, while the enamel of the outer column is still imperforate. The ridges are of considerable vertical height, and each is divided into two portions by the cleft which traverses the longitudinal axis of the tooth. The portion of each ridge on the outer side of this cleft consists of two agglomerated tubercles; while the portion on the inner side consists of one large column or tubercle in the line of the ridge, to the external extremity of which two smaller tubercles are closely attached, projecting on either side into the valleys, and uniting with the corresponding tubercles of the other ridges, thus obstructing the base of each valley. The arrangement of the accessory tubercles causes the worn dentine surface of each main column to form a trefoil-shaped islet, as is shown in the first ridges. Very slight tubercles occur at the inner extremities of the transverse valleys. The enamel is somewhat corrugated, and there are some slight traces of cement in the valleys.

The anterior surface of the tooth presents a large flattened and smooth disc, produced by the pressure of a preceding tooth, which must have been in apposition with it.

The smaller tooth, which has a sub-circular crown, is entirely unworn, and had not perforated the gum at the death of the animal. The summits of the crown of this tooth are nearly on a level with the base of the crown of the larger tooth. The smaller tooth is placed on the anterior side of the larger. The position and condition of wear of the smaller tooth, show that it must be a premolar, and that it has vertically succeeded a worn-out milk-molar, which produced the facet on the anterior surface

of the larger tooth. The relatively large size of the premolar shows that that tooth must be the last of the premolar series, and consequently that the larger tooth must be the first true molar.

The premolar has two ridges, which are considerably higher than those of the corresponding tooth of *Mastodon latidens* described above (Plate XXXVII, fig. 6); the ridges are crowned by distinct cusps. There are well developed fore-and-aft talons. The dimensions of the two teeth are as follows:—

Length of premolar	2·15
Width of ditto	1·8
Height of first ridge of ditto	1·3
Length of true molar	4·2
Width of ditto	2·4
Height of second ridge of ditto	1·7

Comparisons.—The first true molar in the specimen described above differs entirely from the molars of *Mastodon latidens,* which is the only Indian *Tetralophodon* which we have yet described, and it will also be shown to differ from the molars of *M. sivalensis* which are described below. There, therefore, only remains *M. perimensis* to which the specimen can belong, and we find that the characters of the tooth agree precisely with those of the molars of that species noticed above, and I have consequently referred the specimen to that species. In figs. 3 and 4 of Plate IX of the first volume of the "Palæontological Memoirs," a specimen of the same tooth of *M. perimensis* from Perim Island is figured on a small scale, in profile and plan. That tooth was named by Dr. Falconer, and is now in the collection of the Indian Museum. It is rather less worn than the specimen figured here, but agrees exactly, in all its characters, with the exception of being somewhat larger. The length of the Perim Island specimen is 4·5 inches, and its width 2·7. It is probable that the latter belonged to a male, while the Punjab specimen belonged to a female individual.

Comparison with M. longirostris.—The molars of *M. perimensis* present, at first sight, a very striking resemblance to the molars of the European *M. longirostris,*[1] though a closer examination shows certain differences between the two. We have already seen that in the upper molars of *M. perimensis,* only the inner columns of the ridges carry accessory tubercles next the longitudinal cleft, and that consequently these columns alone present during detrition a trefoil-shaped surface of dentine, while the outer columns present an oblong surface. In the molars of *Mastodon longirostris,* on the other hand, both the inner and outer columns of the ridges develope accessory tubercles next the cleft, and both in consequence wear into trefoils, as is shown in Kaup's figures. The trefoil of the outer column, however, does not appear till the inner is partly disappearing, owing to the lesser height of the accessory tubercles of the former. In consequence of this a molar of *M. longirostris,* when slightly worn, carries a trefoil dentine-surface on the inner ridge, and an oblong one on the

[1] See Kaup: "Ossements Fossiles du Muséum de Darmstadt," Pl. XVI.

outer, and these at first sight very closely resemble those of the molars of *M. perimensis.* The molars of the two species are further distinguished by the presence of cement in those of the Indian, and its absence in those of the European species. The general similarity, however, in the plan of the molars of the two species shows that they must be closely related, though the differences noticed above, as well as the dissimilarity in the mandible of the two species, which will be noticed below, affords marked points of distinction between them.

Second upper true molar.—Of the second upper true molar of *M. perimensis,* a specimen from the right side, is represented in profile and plan in figs. 5 and 6 of the plate of the "Palæontological Memoirs" already referred to above; that specimen was obtained from Perim Island, and is now in the collection of the Indian Museum. The figure in plan (6) is somewhat indistinct, and on a small scale, but it suffices to show that the tooth is but little worn, and that it carries four ridges and a large hind-talon (broken in the specimen), and that the inner columns of the ridges wear into trefoils, and the outer into oblongs, while the valleys contain cement. The length of the specimen, allowing slightly for the broken talon, is 5·9 inches, and its width 3·5 inches. The tooth, which is represented in fig. 4 of Plate XLI of this memoir, was obtained by Mr. Theobald in the Punjab, and is from the right side of the upper jaw. It carries four ridges, and a very large hind-talon, and, except in the matter of size, agrees so exactly with the second upper true molar of *Mastodon perimensis* from Perim Island, that I have no doubt that it is the homologous tooth. The presence of the large hind-talon shows that the specimen cannot be the first true molar, in which, as we have already seen, that talon is but very slightly developed. The Punjab second molar is rather smaller than the Perim tooth, as we found to be the case with the first true molars from the same localities. The smaller tooth is probably that of a female.

The figured tooth is well-worn, the dentine discs having become united in the first and second ridges. In the third ridge the dentine surfaces still form islands; in this ridge the dentine of the inner column does not present a trefoil-shaped pattern, as in the anterior ridges at a corresponding state of detrition. The enamel of the fourth ridge is only just perforated by wear. The hind-talon is lower than the last ridge, and is still untouched by detrition; it presents a large median tubercle, flanked by a smaller tubercle on either side. The length of this tooth is 5·4 inches, and its greatest width 2·8 inches. This tooth shows well the great thickness of the enamel, a very characteristic point in the molars of the species.

Comparison with M. longirostris.—If the figured second upper molar of *M. perimensis* be compared with the corresponding tooth of *M. longirostris* in the palate specimen figured by Kaup,[1] it will be seen that the two teeth are almost exactly in the same relative condition of wear, and therefore well adapted for comparison. The Indian tooth differs from the European in possessing a very large talon, which appendage never seems to attain any size in the second molar of the latter. The

[1] *Loc. cit.*, Pl. XVI, fig 5.

two teeth are further distinguished by their wear; in the European tooth the dentine surfaces of the last ridge are much larger than in the Indian tooth, showing that the plane of wear is less oblique in the former than in the latter. Again, in the tooth of *M. perimensis,* the dentine surfaces of the two columns of each ridge seem to unite at an early period of wear, and form a straight band across the tooth; and there is consequently no distinct trefoil in the outer column of the second ridge, which is so conspicuous in the tooth of *M. longirostris* when well worn, as in Kaup's specimen.

Last upper molar.—No specimen of the last upper true molar of *Mastodon perimensis* is figured either in the "Palæontological Memoirs" or in the "Fauna Antiqua Sivalensis," although the cranium represented in Plate XXXVIII of the latter work shows the base of the last true molar, the crown having been hammered off. The magnificent molar of a *Mastodon* represented in Plate XLII of this memoir was collected by Mr. Theobald in the Punjab, and is the last left upper true molar, as may be determined from its form, size, and number of transverse ridges. The tooth is long and narrow, which character alone is sufficient to distinguish it from the corresponding tooth of *M. latidens;* the anterior ridge is the widest, the transverse diameter of the crown gradually decreasing from this point to the posterior extremity, where the tooth is rounded regularly off. This tooth carries five transverse ridges, and a small posterior talon; there is also a small step or ledge at the anterior extremity, which doubtless represents an anterior talon. The ridges are very tall, and are divided by the median cleft into conical inner and outer columns. The two first ridges have been partly worn, and exhibit well the uneven rate of wear of the two sides of the crown, which we have seen to be characteristic of the molars of this species. The general arrangement of the columns of this tooth is much the same as we have seen to prevail in the earlier teeth of the species; the inner column of each ridge wearing into a trefoil, and the outer into an oblong. A few accessory tubercles are developed at the bases of the outer extremities of the transverse valleys, which are not found in the anterior teeth. The fifth ridge is narrower and lower than any of the preceding ridges, and the hind-talon consists of three small low tubercles, the largest of which is placed in front and on the inner side of the others. The tooth shows the thick enamel, and the small amount of cement so characteristic of the species. In the following table the dimensions of this tooth are given, together with those of the corresponding tooth of the opposite side of *M. longirostris* represented in fig. 9 of Plate XVIII of Kaup's "Ossements Fossiles du Muséum de Darmstadt."

	M. perimensis.	*M. longirostris.*
Length	9·6	8·9
Greatest width	3·7	3·9
Height of third ridge	2·8	2·6

Comparison with M. longirostris.—From these measurements it will be seen that the last upper true molar of *M. longirostris* is shorter and broader and has

lower ridges than the corresponding tooth of *M. perimensis.* A comparison of the two figures will, however, show that in general characters the two teeth are exceedingly alike. The European tooth is distinguished, in addition to the difference in relative size, by diminishing less rapidly in width posteriorly, and by the consequent greater size of the fifth ridge and hind-talon: the columns of the ridges are also somewhat less distinctly separate than in *M. perimensis.*

Second lower true molar.—Of the lower dentition of *Mastodon perimensis* the first tooth with which I am acquainted is the second true molar, of which a specimen is represented in fig. 1 of Plate XLI, collected by Mr. Theobald in the Punjab. The tooth has a concave profile, showing that it must belong to the lower jaw; the ridges present a concave surface to the broken end, showing that this must be the posterior extremity, and that the tooth must consequently belong to the left side of the jaw, since the median cleft is nearest the upper border of the figure. From its size the tooth is inferred to be the second of the true molar series. The crown is slightly narrower in front than behind and carries four transverse ridges, (of which the last is broken), and a large posterior talon (also broken); a ledge on the first ridge represents an anterior talon. The ridges are high, and are divided by a median cleft, which, however, is not so distinct as in the upper molars. The summit of each of the four ridges (all of which are quite unworn in the specimen) terminates in about six blunt cusps; the portion of each ridge placed externally to the median cleft (lower half of figure) would wear into trefoils, owing to the presence of accessory tubercles in the valleys, along the median line of the tooth, which block the valleys. Cement is present in the valleys. The length of this tooth is 5·1 inches, and its width 2·8 inches. The size of this tooth agrees, therefore, with that of the second upper true molar from the Punjab, which has been described above; from this, and from the presence of a large hind-talon in both, the lower molar has been considered as the second of that series. The somewhat greater simplicity in structure of this lower molar, as compared with the corresponding upper tooth, is similar to that which occurs in *M. longirostris.* A well-worn specimen of the second left lower true molar of *M. perimensis* from Perim Island is represented in fig. 10 of Plate XXXI of the "Fauna Antiqua Sivalensis." That tooth has a length of 4·8 inches, and a width of 2·6 inches. Allowing for the one tooth being a germ, and the other much worn, the two teeth in question seem to have the same form: in Falconer's specimen the hind-talon is seen to consist of two large cones, only one of which remains in Mr. Theobald's specimen.

Last lower true molar.—A specimen of the last lower true molar of the present species from Perim Island is represented in fig. 11 of the last quoted plate of the "Fauna Antiqua Sivalensis." The tooth carries five ridges and a large hind-talon, and agrees in all essential characters with the last upper molar figured in the plates accompanying this memoir. The length of the lower molar is 8·4 inches, and its greatest width 3·5 inches. A very similar tooth, collected by Mr. Theobald, is in the collection of the Indian Museum, but I have not thought it necessary to give a

figure of that specimen. Another last lower molar in a nearly complete mandible from the Punjab has a length of 10·7 inches, and a width of 4·4 inches.

Mandible.—In a notice published in the "Records,"[1] I have recorded the acquisition by the Indian Museum of a complete specimen of the adult mandible of *M. perimensis*, obtained by Mr. Theobald in the Punjab. The specimen has not been figured here, owing to its very large size, and the consequent difficulty of getting an accurate drawing of it with the means at my disposal. The specimen shows the last true molar and a portion of the penultimate tooth. The ramus is sub-circular in cross section with a slight lateral compression; it bulges out below the last molar; the lower border of the ramus is very slightly convex posteriorly, and as slightly concave below the symphysis. The latter is produced into a short trough-like symphysis similar to that of the specimen represented in fig. 2 of Plate XLIII. In the figured specimen there is seen at the anterior fractured extremity, in transverse section, a pair of small incisors, with a pyriform section. In the complete mandible, of which the symphysis is entire, there are no incisors; the figured specimen probably belonged to a male, and the other to a female. The dimensions of the complete mandible are as follows :—

Length from hinder border of last molar to distal end of symphysis	29·0
Ditto from anterior border of penultimate ditto to ditto	13·5
Ditto of last molar	10·7
Interval between condyle and coronoid process	5·0

The form of the symphysis of the mandible is of itself quite sufficient to distinguish *M. perimensis* from *M. longirostris*,[2] in which the symphysis is longer, wider, and more deflected, with a shallower spout. The lower border of the ramus of the latter is much bent, whereas that of the former is nearly straight. In *M. longirostris* there is a considerable lateral compression of the rami, totally wanting in *M. perimensis*.

Undetermined mandible.—In fig. 1 of Plate XLIII, I have had lithographed another symphysis of the mandible of a *Mastodon*, bearing a considerable general resemblance to that of *M. perimensis*, but also presenting some points of difference. Its main point of difference is that in place of having a deeply hollowed spout-like symphysis, it has only a very slight hollowing out of the produced symphysis, and swells out anteriorly, while the symphysis of the typical tuskless form of *M. perimensis* (as shown in the large unfigured mandible) tapers somewhat more to a point. The trough in the latter mandible is, however, somewhat less deep than in the figured tusked specimen, and I am inclined to think that the specimen represented in fig. 1 must also be referred to a variety of *M. perimensis*. That specimen certainly cannot belong to either *M. pandionis* (Plate XXXVI fig. 1) or *M. sivalensis*;[3] its depth, when broken posteriorly, is too great to have fitted on to the

[1] Rec. Geol. Surv. India, Vol. XI, p. 71.
[2] "Fauna Antiqua Sivalensis," Pl. XLV, fig. 10.
[3] *Ibid.*, Pl. XXXV, fig. 1.

slender jaw of *M. latidens* noticed above, and I do not think from its form that it belonged to *M. falconeri*; if it does not belong to *M. perimensis*, it therefore must belong to a new species.

Cranium.—In noticing the cranium of *M. perimensis* figured in Plate XXXVIII of the "Fauna Antiqua Sivalensis," Dr. Falconer makes the following remarks:—"The cranium is in many respects singularly perfect, although it has suffered from a crushing force, which has forced in the temples, so as to have contracted to a few inches the inter-temporal portion of the forehead. The ascending ramus of the lower jaw on either side is *in situ*, with the coronoid process and condyle, and what is more remarkable, the greater part of the hyoid bone lies upon the sphenoid. The atlas also was found attached to the condyles. The teeth are completely hammered down to the margin of the alveoli. The most remarkable character of all about this head is the low height of the pterygoid processes of the sphenoid, which are very little higher than the condyles, and the comparatively little elevation of the condyles above the palate. The interval between the plane of the lower surface of the condyles and that of the palate is only 5 inches, the height of the occiput being 22 inches. This is very much as in the North American *Mastodon*, and even more so, so that the plane of the grinder does not differ much from that of the condyles, thus showing a tendency in the direction of *Dinotherium* and the Trilophodon *Mastodon ohioticus* (*maximus*). The pterygoids rise with a sharp posterior border, aad do not spread out into a flap over the posterior border of the maxillary. They are not rugous as (in) *M. ohioticus*, nor are they so far (proportionably) extended behind. There are two large palatine foramina near the end of the molar. The molars (allowing perhaps for some distortion from pressure) run parallel and do not at any rate diverge in the remarkable way exhibited by *M. ohioticus*; perhaps they are less divergent even than in *M. sivalensis*. The palate looks long. On either side are two molars, the penultimate and last true. The tusks exhibit an oval outline in section."

The length of the last molar is only 7·4 inches, so that this cranium must have belonged to a much smaller individual than that to which the last upper molar figured in the accompanying plates (Plate XLII), or than that to which the mandible noticed above, belonged. It is probable that the Perim Island skull, together with the last lower molar figured on the adjoining plate of the "Fauna Antiqua Sivalensis," belonged to a female. I believe that no complete specimen of the cranium of *Mastodon longirostis* has hitherto been discovered, so that we are unable to compare the cranium of the latter and that of *M. perimensis*. Kaup has, however, figured[1] a specimen of the palate of the former species with the penultimate and last true molars; and if that figure be compared with the palate of *M. perimensis* represented in the "Fauna Antiqua Sivalensis," it will be seen that the molars in the former are much less closely approximated than in the latter, and appear to be somewhat proportionately wider.

[1] Loc. cit. Pl. XVI, fig. 5.

General characters and differences.—Summarizing what is known regarding this species, we find that, as far as we are at present acquainted with it, the dentition follows the normal tetralophodont law in respect to the number of ridges carried on the crowns of the molars. Premolars were developed in the upper jaw, and, therefore, probably also in the lower; the mandible is produced into a trough-like symphysis, intermediate in length between that of the living Indian elephant and that of *M. pandionis;* it was furnished with incisors in some individuals, which were wanting in others. The molars carry tall ridges, of which the columns develope accessory tubercles blocking the transverse valleys; one of the columns of each of the anterior ridges when worn down, presents on its summit a trefoil-shaped islet of dentine. Cement is present in small quantity in the valleys. The characters of the cranium have already been pointed out.

In the form of its molars this species approaches nearest to the European *M. longirostris,* but is at once distinguished by the form of the mandible and by certain characters of the molars already pointed out.

The molars of the tetralophodont *Mastodon dissimilis* of Jourdan,[1] from the upper Pliocene of the Rhone valley, are of the type of those of *M. perimensis,* but as is well shown in the last upper molar, the ridges have a greater tendency to an alternate arrangement of their columns and show less distinct trefoils of dentine, than in *M. perimensis.* The last upper molar of the European species is more oblong in form than that of the Indian, not contracting posteriorly as the latter does, and the hind-talon consequently being of greater relative width. Other smaller differences in the teeth of the two species will be seen on comparing the figures. There are no figures of the cranium or of the complete lower jaw of *M. dissimilis* given in the plates quoted in the note.

It will probably have struck the reader that in regard to the shape of the ridges, the molars of *M. perimensis* present a striking resemblance to those of *M. falconeri,* the two being, however, broadly distinguished by the one having a tetralophodont, and the other a trilophodont arrangement of the ridges in the intermediate molars. The two species, as far as I can judge from the broken mandible of *M. falconeri,* are further distinguished by the form of the mandible, which is more convex inferiorly and thicker in *M. falconeri;* in the latter species there are no premolars and no cement, both of which occur in the other species. It is unfortunate that I have not been able to trace *M. perimensis* through its milk-molar dentition, and it might be argued from this that both species had trilophodont milk-molars, and both tri-and tetralophodont true molars. Apart, however, from the important distinctions already pointed out, the last milk-molar of *M. falconeri* (Plate XXXII, fig. 3) (which is exactly like the first true molar in the same young

[1] Lortet and Chantre: "Mastodontes du Bassin du Rhone." Archiv. du Mus. d'Hist. Nat. de Lyons, Vol. II, Pls. I-VII Lyons, 1878. Only the plates of the molars of this species have yet reached India, the letter-press being in a succeeding number.

skull) is so utterly unlike the first true molar of *M. perimensis* (Plate XL), that this alone would be sufficient grounds of distinction.

An analogous instance of two species of *Mastodon*, the one with a trilophodont and the other with a tetralophodont formula, is afforded by the European *M. angustidens* and *M. longirostris*, in both of which the true molars are formed on the same general plan, and present trefoil islets of dentine on their worn columns.[1]

Distribution.—Remains of this species have been obtained from the Siwaliks of the Punjab to the west of the Jhelum and in Perim Island. I am not quite sure whether this species occurs in Sind, as I have some fragmentary molars from that district which may belong to *M. perimensis*. As no specimens of the teeth of this species were obtained by Falconer and Cautley in the more easterly Siwaliks or Burma, it is probable that this species did not extend its range much to the east of the Jhelum.

Species 5: Mastodon sivalensis, Falconer & Cautley. Pls. XLI, fig. 2, XLIV.

History.—The first notice of *Mastodon sivalensis* seems to have appeared in a paper read by the late Sir Proby (then Captain) Cautley before the Asiatic Society of Bengal in June 1836.[2] In that paper it appeared that the author considered certain molars of a *Mastodon à dents étroites* from the Siwalik hills to belong to a *variety* of the *Mastodon angustidens*[3] of Cuvier; to this variety he gave the name of *M. sivalensis*. In a paper published in December of the same year in the "Journal of the Asiatic Society of Bengal"[4] by the same author, the same conclusion was arrived at as to the specific relations of this Siwalik *Mastodon*.

It thus appears that the name *Sivalensis* was given by Sir Proby Cautley alone. In Dr. Falconer's subsequently published table of the species of *Mastodon* and Elephant,[5] *Mastodon sivalensis* appears as a distinct *species*, with the names of both Falconer and Cautley affixed to it. In that table the species is placed among the tetralophodont *Mastodons*, with the description "Colliculi numero 5, obtusi alternatim mammillæ, valliculæ interruptæ," with the remark "the only known species indicating a Pentalophodon-type." In the same memoir[6] (which was published in April 1857), Dr. Falconer remarks:—"*Mastodon sivalensis* is regarded as having five ridges to the intermediate molars, instead of four; but this remarkable character being restricted at present to a single species, it was deemed inexpedient to form a systematic section for it alone, and it is ranged at the end of the

[1] Pal. Mem., Vol. II, Pl. III.

[2] Jour. As. Soc., Bengal; Vol. V, p. 294; Pal. Mem., Vol. I, p. 126.

[3] *M. angustidens* included the tetralophodont *M. arvernensis*, as well as the trilophodont form to which the me is now restricted.

Pal. Mem., Vol. I, p. 127.—J. A. S. B. Vol. V, p. 768.

[5] *Ibid.*, Vol. II, pp. 14, 15.

[6] *Ibid.*, p. 18.

Tetralophodons.—In a subsequent paper communicated (but not then published) to the Geological Society of London in June 1857,[1] Dr. Falconer[2] says: "In the preceding part, when discussing the conditions of the 'ridge-formula' in *Trilophodon* and *Tetralophodon,* it was stated that while the penultimate milk-molar always presents one ridge less than the intermediate molars, the last true molar presents one ridge more. Conformably, the last true molar in *M. sivalensis* presents six ridges, besides the hind 'talon,' thus maintaining throughout, so far as the dentition is known, the numerical characters to be inferred from the ridge-formula, as ascertained in *Trilophodon* and *Tetralophodon.* I consider it sufficient, on the present occasion, to call attention to this as a point of some interest and importance in the systematic and palæontological relations of the Proboscidian family, in reference to the indications they present of an order of successive serial development, without entering in detail upon the evidence in support of the view here taken. That the species is a distinct form is abundantly borne out by the marked characters of the skull, independently of the strong dental characters. The ridge-formula for the true molars in *Mastodon sivalensis* is inferred to be—

$$\frac{5+5+6}{5+5+(6-7)}$$

and when the dentition is fully made out, it is anticipated that the complete ridge-formula will be nearly thus—

Milk-molars.	True molars.
$\frac{2+4+5}{2+4+5}$	$\frac{5+5+6}{5+5+(6-7)}$."

It thus appears that in his last notice, Dr. Falconer considered *M. sivalensis* to have a complete pentalophodont ridge-formula.

In Plates XXXII and XXXIII of the "Fauna Antiqua Sivalensis" a figure of a fairly complete cranium of the species is given, while in Plates XXXIV to XXXIX of the same work a considerable series of the teeth are figured. From these figures and from various notes by Dr. Falconer, we gather that the molars of this species are characterized by being narrow, and with complex crowns, on which the columns of the ridges are placed alternately so as to completely block the valleys. The columns are tall, and when worn present irregularly shaped discs of dentine, and there is no cement. The mandible is represented in fig. 1 of Plate XXXV of the "Fauna Antiqua Sivalensis" and is characterized by a very short spout-like symphysis.

First lower milk-molar.—I cannot find any specimen of the first upper milk-molar of *M. sivalensis,* and the first tooth we have, therefore, to consider, is the first lower milk-molar, a specimen of which is contained in each of two specimens of the

[1] Pal. Mem., Vol. II, p. 1.
[2] *Ibid,* p. 87.

mandible of calves represented in figs. 1 and 2 of Plate XXXVII of the "Fauna Antiqua Sivalensis." In both these specimens the crown of the tooth has been hammered off. The length of the more perfect tooth is 0·6 inch, and its greatest width 0·4 inch.

Second upper milk-molar.—Two specimens of the second upper milk-molar of *M. sivalensis* are represented in figs. 1 and 2 of Plate XXXVI of the "Fauna Antiqua Sivalensis." The first of these specimens is detached, the second is in a fragment of the maxilla, which also contains the third milk-molar. The second milk-molar seems to be somewhat oval-shaped, and carries three ridges, the hindmost of which is shorter than the others. The length of this tooth is 2·6 inches, and its greatest width 1·8 inches.

Second lower milk-molar.—Each of the two fragmentary mandibles referred to above as containing the first milk-molar, also contains a succeeding tooth, which must accordingly be the second milk-molar. This tooth, like the corresponding upper tooth, carries three transverse ridges, and has a length of 1·9 inches and a width of 1·2 inches. These dimensions are slightly smaller than those of the corresponding upper milk-molars, both of which, as we shall see below, probably belonged to male animals.

Third upper milk-molar.—A specimen of the third upper milk-molar is represented in fig. 2 of Plate XXXVI of the "Fauna Antiqua Sivalensis." This tooth carries four ridges with alternately arranged columns, and has a length of 4 inches and a width of 2·3 inches. This tooth, as far as regards form, agrees exactly with the smaller specimen represented in fig. 2 of Plate XLI of this memoir. The latter specimen was transferred from the collection of the Asiatic Society of Bengal to the Indian Museum, and is described on page 38 of the Catalogue of the Fossil Vertebrata in the Society's collection by Dr. Falconer as follows :—

"Fine specimen of the upper maxilla, left side, comprising the greater portion of the palate and two molars embedded in the jaw, with four empty pits, marking the situation of the fangs of the second milk-molar, which had fallen out. The third milk-molar (figured tooth) is shown nearly entire with the enamel (of the) crown broken off at the outside of the first two ridges; the first three ridges are seen to be touched with wear, forming depressed cups. The crown of the tooth is bisected longitudinally into an outer and inner division, and the groups of mammillæ are seen to alternate with accessory mammillæ in the valleys. The surface of the enamel is deeply grooved vertically, so that the ridges when worn present a very complex pattern. Behind the fourth ridge is a talon consisting of a complicated group of small mammillæ. The four empty fang cavities in front are (arranged so as to form) nearly a square, showing that the crown of the tooth had a similar form."

The length of the third upper milk-molar is 3·2 inches and its greatest width 2 inches. The alveolar space of the second milk-molar occupies a square of about 1·3 inches in diameter.

It is probable that the third milk-molar figured here belonged to a female, while the specimen figured in the "Fauna Antiqua Sivalensis" belonged to a male animal.

In the jaw in which the figured third upper milk-molar is implanted there are no traces of any premolar, either above that tooth, or having replaced the second milk-molar, which has fallen out; from this we may conclude that premolars were not developed in *Mastodon sivalensis.*

The serial position of the figured third upper milk-molar is of considerable importance, as from it we are enabled to determine the position of some other teeth, and I will therefore recapitulate the grounds upon which its position is fixed. The figured tooth corresponds exactly in form with the larger tooth represented in fig. 2 of Plate XXXVI of the "Fauna Antiqua Sivalensis," which again has in front of it a tooth of such a large size that it must be the second milk-molar; hence the larger tooth must be the third of that series.

The third upper milk-molar figured here has behind it three ridges of a larger tooth, which must consequently be the first true molar, to which we shall have to refer again.

Third lower milk-molar.—The tooth represented in fig. 2 of Plate XLIV is implanted in a fragment of the right ramus of the mandible, and was obtained by Mr. Theobald in the Siwaliks of the Kangra district. As it is larger and contains one ridge more than the above noticed second lower milk-molar figured in the "Fauna Antiqua Sivalensis," it must be the third lower milk-molar, or the corresponding lower tooth to the third upper milk-molar, represented in fig. 2 of Plate XLI. The last ridge of this tooth has been somewhat damaged, and the posterior talon completely broken away. The crown is long and narrow, with the outer border concave and the inner convex. The inner extremity of each ridge is considerably higher than the outer. Each of the three ridges which are uninjured are worn, and exhibit irregularly shaped hollows of dentine. The ridges are of considerable relative height, and each is mesially divided by the cleft traversing the longitudinal axis of the crown into an inner and an outer column. These columns are arranged alternately so that each ridge is set obliquely to the long axis of the crown, in such a manner that its inner column is considerably in advance of its outer column. By this arrangement, aided by the presence of some outlying tubercles, the transverse valleys are completely blocked. The length of this tooth is 3·4 inches, and its greatest width 1·8 inches. The height of the somewhat worn penultimate ridge is 1·3 inches. In fig. 3 of Plate XXXVII of the "Fauna Antiqua Sivalensis," there is figured a worn third lower milk-molar of *M. sivalensis* which seems to have carried four ridges, and which, as regards form and size, agrees almost exactly with the specimen figured here.

Ridge-formula of the milk-molars.—From the specimens of milk-molars figured here and in the "Fauna Antiqua Sivalensis," the serial positions of which are fixed beyond the possibility of doubt, it is quite clear that these teeth always follow the

normal tetralophodont law, and their ridge-formula may accordingly be expressed as follows :—

$$\text{Milk-molars } \frac{2+3+4}{2+3+4}$$

Falconer's conjectural ridge-formula of the milk-molars of the species noticed above is consequently incorrect. With the evidence of the specimens figured in the "Fauna Antiqua Sivalensis," and described in the "Catalogue of the Fossil Vertebrata in the Museum of the Asiatic Society of Bengal" before him, it appears, to say the least, very curious that Falconer should have put forward the pentalophodont formula for the milk-molars of *M. sivalensis.* The only possible exception to this rule would be the case of a lower jaw in the Museum of the College of Surgeons referred to by Falconer in a note to the description of Plate XXXVII of the "Fauna Antiqua Sivalensis." It is, however, probable that the tooth there considered as the last milk-molar is really the first true molar, as we shall see below.

First upper true molar.—At page 47 of the "Catalogue of the Fossil Vertebrata in the Asiatic Society of Bengal," Dr. Falconer shortly notices a palate of *M. sivalensis* containing the last milk-molar and the first true molar (No. 13). The position of these teeth is determined from their identity with the two corresponding teeth in the jaw which contains the third upper milk-molar figured in Plate XLI, fig. 2, of this memoir. In the latter jaw, as already said, the first true molar is imperfect, but in the former it is complete, and is shown to have four ridges and a hind-talon. It has a length of 4·2 inches and a width of 2·4 inches. I have not figured this tooth, because it is a good deal damaged and chipped. I cannot find any specimen of a five-ridged tooth which I can certainly refer to the first true molar. The characters of the first upper true molar are so exactly similar to those of the milk-molars that I have not thought it necessary to give any description of that tooth.

First lower true molar.—To the description of Plate XXXVII of the "Fauna Antiqua Sivalensis" Dr. Falconer adds a note (1) in which he describes a lower jaw of *Mastodon sivalensis* in the College of Surgeons which contains a complete six ridged tooth followed by a larger incomplete tooth. The former has a length of 4·2 inches and a width of 2·4 inches. The width of this tooth is considerably greater than that of the third lower milk-molar figured here, from which fact, coupled with its high ridge-formula, I think that this tooth is probably the first true molar and not the last milk-molar, as it is considered by Falconer.

I cannot find any other complete tooth which I can certainly class as the first lower true molar of this species, though I think it probable that specimens will eventually be found with either four or five ridges.

Second upper true molar.—In fig. 4 of Plate XXXVI of the "Fauna Antiqua Sivalensis" there is figured a tooth which seems evidently to be the second upper true molar of *M. sivalensis,* and which seems to have four ridges and a large hind-talon. Its length is 5·6 inches, and its width 2·9 inches. In fig. 5

of the same plate there is another specimen of the same tooth which has five ridges and a talon. Its length is 6·5 inches and its width 2·9 inches.

In the palate specimen figured in Plate XXXIV, fig. 1, of the "Fauna Antiqua Sivalensis," containing the second and third true molars, the former tooth has four ridges and a talon, and has a length of 4·7 inches and a width of 2·8 inches. A very similar palate in the Indian Museum also shows the second true molar with four ridges and a hind-talon.

The number of ridges in this tooth may, therefore, be four or five.

Second lower true molar.—There is no complete specimen of the second lower true molar of this species either in the collection of the Indian Museum, or among the series figured in the "Fauna Antiqua Sivalensis." The imperfect specimens, however, seem to indicate that this tooth, in some instances, carried five ridges.

A specimen of the homologous tooth in the Museum of the College of Surgeons, referred to by Falconer in a note (2) to the description of Plate XXXVII of the "Fauna Antiqua Sivalensis," has only four ridges and a talon.

This tooth, therefore, like the corresponding upper molar, may have either four or five ridges.

Third upper true molar.—In fig. 6 of Plate XXXVI of the "Fauna Antiqua Sivalensis" there is represented a complete last upper true molar of *Mastodon sivalensis.* This tooth has six ridges and a hind-talon, and a length of 7·8 inches and a width of 3·3 inches. It has the alternate arrangement of the columns very conspicuously displayed.

In the palate specimen represented in fig. 1 of Plate XXXIV of the same work, the last molar has five ridges and a hind-talon. On this tooth Dr. Falconer remarks :—

"The front ridge has two confluent ridges on the outside, to the inner of which the intermediate pillar is attached, joining on with the innermost large point of the third ridge. This third ridge shows but one thick point on the inner division, and two on the outer, with the intermediate pillar connecting the outer division of the third with the inner division of the fourth ridge, and so with the last ridge. This diagonal connection of the posterior surface of the outer division with the anterior surface of the inner points of the next following ridge causes in wear the alternate-like discs of detrition, which characterize the teeth of *Mastodon sivalensis.*"

In fig. 1 of Plate XLIV of this memoir, there is drawn a very fine specimen of an almost unworn last upper molar of a *Mastodon,* taken from the left side of a palate specimen collected by Mr. Theobald in the Siwaliks of the Punjab. It is inferred to belong to *M. sivalensis* from its narrowness, general complexity of pattern, and somewhat alternate arrangement of the columns, though this latter character is not so well marked as in Falconer's specimens. The tooth is preceded in the palate by a much worn and smaller tooth, in which the number of ridges

originally carried on the crown cannot now be determined. The figured tooth carries six transverse ridges and small fore-and-aft talons; its ridges are divided by a median cleft into inner and outer columns. Accessory columns are present in the valleys. When worn down, the columns would present irregularly shaped discs of dentine on their summits, and not trefoils (the preceding molar in the palate shows these irregular discs). As before said, the columns are not arranged in our specimen in nearly so alternate a manner as in Falconer's specimens of the last upper molar of *M. sivalensis;* it will, however, be seen from other teeth figured in the "Fauna Antiqua Sivalensis" (and also from the specimens in the Indian Museum), that there is considerable variation in this respect, as also in the number of accessory tubercles. In consequence of this different arrangement of the columns of the ridges in our specimen and Falconer's specimens, the valleys are much less blocked in the former than in the latter.

The last upper molar of the species may, therefore, carry either five or six ridges.

Third lower true molar.—Specimens of the third lower true molar of *M. sivalensis* are represented in the "Fauna Antiqua Sivalensis" (Plate XXXV, fig. 1, Plate XXXVII, figs. 7 and 8), all of which carry six ridges and a hind-talon. The ridges are disposed alternately, and a few accessory tubercles, which may vary in number, are present in the valleys. The specimen represented in fig. 8 of the latter plate has a length of 8·8 inches and a width of 2·9 inches.

In fig. 3 of Plate XLIV of this memoir, a tooth is figured, which is implanted in a nearly complete, though somewhat crushed mandible, which was collected by Mr. Theobald in the Punjab. This tooth, though differing in the number of ridges from Falconer's specimens, seems probably to be the last lower molar of *M. sivalensis.* The figured tooth is from the right ramus of the mandible, and as it is well worn and has no tooth succeeding it from behind, must be the last of the series.

This tooth carries five ridges and a very small hind-talon. The last ridge is the smallest. This last ridge consists of a very distinct inner and outer column, separated by a median cleft. The worn summit of each column presents an irregularly shaped and depressed islet of dentine. The columns have only a very slight alternate arrangement. In each valley there is a cluster of accessory tubercles, which are in general attached to the preceding ridge. The first valley has four tubercles, the second three, the third two, and the fourth one.

If this tooth be compared with the corresponding tooth of *Mastodon pandionis* represented in fig. 4 of Plate XXXV, it will be seen, as already noticed, that the two are almost identical in form, if the large talon in the latter be counted as a fifth ridge; and indeed if the two teeth had been found detached, they would almost certainly have been referred to the same species. It will, however, be remembered that the tooth of *M. pandionis* was implanted in a fragment of the mandible to which belonged the enormous symphysis represented in fig. 1 of Plate XXXVI. The figured

tooth of *M. sivalensis*, on the other hand, is implanted in a complete mandible, which, though slightly broken at the symphysis, shows that such symphysis was short like that of the living Indian elephant, and in fact agrees exactly with the mandible of *M. sivalensis* represented in figs. 1 and 1*a* of Plate XXXV of the "Fauna Antiqua Sivalensis," which carries a six-ridged tooth with alternately disposed columns. From this identity in form of the two mandibles, and from the similar general structure of the two teeth, I have referred the specimen figured here to *M. sivalensis*.

If the latter tooth be compared with the tooth of *M. pandionis*, it will be found that there is a little difference in the disposal and wear of the outlying tubercles in the two, while the hinder ridges are relatively highest in *M. pandionis*. The most important mark of distinction, however, is that the wear of the tooth of *M. pandionis* is almost in one plane, whereas the tooth of *M. sivalensis* is deeply concave in the middle.

The figured tooth of *M. sivalensis* differs from the specimen figured in Plate XXXVII, fig. 8, of the "Fauna Antiqua Sivalensis," in having one ridge less, less alternately disposed columns, and more accessory tubercles.

Relationship to Mastodon arvernensis.—We have already seen that Sir Proby Cautley thought that the molars of *M. sivalensis* could not be distinguished specifically from those of *M. arvernensis* of the English Crag, [1] and the subsequent researches of Falconer confirmed this close relationship. Both species agree in the alternate arrangement of the mammillæ of the ridges, but the mammillæ of the European molars are generally less alternate than those of the Indian. The European species does not seem to have any tendency to a pentalophodont type, and is further distinguished by having premolars, [2] which seem to be absent in the Indian species. Both species seem to have had a short elephantine mandible, without tusks. [3]

The cranium of *M. arvernensis* is, I believe, unknown, and cannot therefore be compared with the very peculiar cranium of *M. sivalensis*.

There can be no question but that the two forms are very closely allied. The differences indicated above afford, however, amply sufficient grounds for the specific distinctness of the two forms.

Relationship to M. pandionis.—*Mastodon sivalensis* may be regarded as presenting the same kind of relationship to the trilophodont *M. pandionis*, as we have already shown to exist between the tetralophont *M. perimensis* and the trilophodont *M. falconeri*. In both the two first-named species the pattern of the crown of the molars is complex, with alternate columns, accessory outlying tubercles, blocked valleys, and irregularly shaped discs of dentine. The early molars of the two species are very different.

[1] Included at that time under the name of *M. angustidens*.

[2] Pal. Mem., Vol. II, p. 34.

[3] *Ibid.*, p. 44.

Distribution.—Remains of *M. sivalensis* have been obtained throughout the sub-Himalayan Siwaliks, and not, as far as I am aware, elsewhere.

General conclusions regarding Mastodon molars.

The foregoing survey of such a large series of *Mastodon* molars has led to the conclusion that the very regular ridge-formula given by Falconer will not always hold good in regard to the true molars, though in the Indian species, at all events, it appears to be always constant in the milk-molars. We have seen that there is a tendency in the true molars of some of the *Trilophodons* (*M. falconeri*) to develope the talon into a fourth ridge, and in the *Tetralophodons* (*M. latidens* and *M. sivalensis*), a similar talon is developed into a fifth ridge, in the intermediate true molars. We thus see the passage from a *Trilophodon* to a *Tetralophodon*, and from the latter to a *Stegodon*.

We have no instance of a tooth with a certain number of ridges ever being succeeded by a tooth with a smaller number: neither have we at present any instance of a trilophodont being mixed with a tetralophodont formula in the same species.[1]

Genus 2: ELEPHAS, Linné.

Elephants, whose intermediate molars always have more than five ridges, and in which cement is present in considerable quantity.

Sub-Genus 1: Stegodon, Falconer.

Elephants, whose intermediate molars do not generally have more than eight low ridges, and in which the cement does not form a continuous surface with the ridges in the germ molars.

Species 1: Stegodon clifti, Falconer and Cautley. Plate XLV, figs. 1 & 2.

Synonyms: *S. sinensis*, Owen.
Mastodon elephantoides, Clift.

History.—Remains of this species were first obtained by the late Mr. Crawfurd from strata near Ava, in 1826, and a specimen of the palate, and of the first upper true molar, were figured by the late Mr. Clift in the "Transactions of the Geological Society of London,"[2] under the names of *Mastodon latidens* and *Mastodon elephantoides*. In the only part of the letter press of the "Fauna Antiqua Sivalensis," which ever appeared, and which was published in 1846, the authors pointed

[1] I am here referring only to Indian species, and do not therefore mention *M. andium*.

[2] Second Ser., Vol. II, Pls. 36 and 39, fig. 6.

out that Clift had confused the remains of several species under the name of *M. elephantoides*, and they accordingly gave a new name to the two species of "transitional Mastodons," which had been partly mixed up with *Mastodon latidens*. To the elephant teeth with six ridges they gave the name of *Elephas cliftii*, and to the teeth with a greater number of ridges *E. insignis*.[1] In a subsequent paper,[2] these and other species appeared under the sub-generic name of *Stegodon*, proposed by Dr. Falconer.

Distribution.—All the specimens of the molars of *Stegodon cliftii* figured in the "Fauna Antiqua Sivalensis" were obtained from Burma, and it is not certain whether the authors of that work had seen any authentic specimens from the sub-Himalayan Siwaliks, though one specimen in the collection of the Asiatic Society of Bengal was doubtfully said to have come from the Indian Siwaliks. Subsequent researches have, however, shown that the species is of not uncommon occurrence in the Siwaliks of the Punjab, and a considerable number of specimens of the teeth and jaws are now exhibited in the Indian Museum, obtained from that district. One of these specimens is a palate with the two penultimate molars, each of which has six ridges, and which is almost exactly similar to the specimen figured by Mr. Clift in Plate XXXVI of his above-quoted memoir. Another specimen, the last lower true molar, has been previously noticed by myself in the "Records."[3] We shall subsequently see that the species probably occurs in China.

Characters of molars.—The characters of the molars of *Stegodon cliftii*, as given by Dr. Falconer in various notices,[4] are as follows: The first and second true molars have only six ridges, continuous across the crown, and chevron-shaped, with numerous mammillæ or cusps. The cement does not fill up the interval between these ridges, but occurs only, in inconsiderable quantities, in the hollows. The outer side of the upper molars is higher than the inner, in which character the species differs from all the other *Stegodons* named by Falconer, in the molars of which the central part of the ridges is the highest. In all these characters the molars of *S. cliftii* are intermediate between those of the *Mastodons* and those of the other *Stegodons*. A complete milk-molar was not known to Falconer, but he inferred that the last milk-molar would carry five or six ridges.

Second upper milk-molar.—In the "Quarterly Journal of the Geological Society of London" for 1870,[5] Professor Owen described a penultimate upper milk-molar of a *Stegodon* obtained from China, under the name of *S. sinensis*, considering it to be distinct from any of Falconer's species. Of this tooth the Indian Museum has lately obtained a cast, through the courtesy of the Trustees of the British Museum, which is figured in Plate XLV, fig. 2, of this memoir. In regard to this tooth I have come to a conclusion directly opposed to that of Professor Owen, and con-

[1] "Palæontological Memoirs," Vol. I, p. 82.
[2] *Ibid.*, Vol. II, p. 14.
[3] Rec. Geol. Surv. of India, Vol. XI, p. 72.
[4] Pal. Mem., Vols. I, p. 82, II, p. 84.
[5] Vol. XXVI, p. 417, Pl. XXVII.

sider that the tooth in question really belongs to *Stegodon cliftii.* Before I had obtained the cast of the tooth, I accepted the conclusions at which Professor Owen had arrived concerning it, and from the evidence of a single common character, referred the tooth of another *Stegodon* to the same species, although I now find that such identification was completely erroneous.[1]

The Chinese tooth is a small oblong molar, narrower in front than behind, carrying four complete ridges, and an anterior talon, connected with the centre of the first ridge. The grinding surface of the crown is slightly convex antero-posteriorly, thereby showing that the tooth belongs to the upper jaw, while the lower border (in the figure) of the ridges being the most worn, shows that it belongs to the left side; its size shows that the tooth must be the second or penultimate milk-molar. All the ridges have been abraded by wear, and the inner portion of each ridge is the lowest and the most worn; the dentine surfaces consequently present a pear-shaped form. The first ridge is nearly straight, but the succeeding ridges are somewhat bent, the inner halves being slightly in advance of the outer. There is a slight constriction at the point where the ridges are bent, probably representing the mesial cleft which occurs in the molars of the *Mastodons.* Each ridge when unworn probably carried on its summit a considerable number of cusps or mammillæ. The length of this tooth is 2·8 inches, and its greatest width 2·1 inches. Professor Owen in describing the tooth reckons the imperfect anterior ridge as a true ridge, and not as a large talon, as I have done.

In referring the tooth to its proper species, Professor Owen proceeds to compare it with the teeth of *Stegodon insignis*, *S. ganesa*, and *S. bombifrons.* This comparison is, however, unnecessary, because the Chinese tooth differs *in toto* from the molars of the three above-named species, in all of which the centre of the tooth, and not the outer side, is the highest point. The corresponding tooth of the first-named species differs also in having a greater number of ridges.

The upper molars of *Stegodon cliftii*, on the other hand, as we have already seen, are characterized by having the outer sides higher than the inner, and by the dentine surfaces of the ridges being wider internally than externally, as is shown in the figure of the first upper molar given by Clift.[2] We thus see that in one very important character the Chinese milk-molar agrees with the molars of *S. cliftii*, and with those of no other species of the genus. The latter molars, moreover, have a low ridge-formula, in which respect also they agree with the Chinese tooth. It now, therefore, remains to enquire on what grounds Professor Owen referred the Chinese tooth to a distinct species. The Professor appears to have overlooked the manner of wear of the ridges, and observes that the Chinese tooth[3] cannot belong to *S. cliftii*, because in the molars of that species there is "no mark of a longitudinal line bisecting

[1] Rec. Geol. Surv. of India, Vol. XI, p. 73. See also below. In a paper published in the IXth Volume of the Records (p. 49), when showing that *S. orientalis* was founded on an insufficient character, I joined to it the name of *S. sinensis*, whose specific distinctness does not depend on the same character.

[2] *loc. cit.*, Pl. XXXIX, fig. 6.

[3] *loc. cit.*, pp. 419-20.

the tooth into an outer and an inner division," and because the ridges in the latter are not bent. Now, with regard to the first of these two negative characters, Dr. Falconer himself, in describing the upper molar of *S. cliftii*, represented in fig. 1 of Plate XXX of the "Fauna Antiqua Sivalensis," says, that the "mesial line of division of the ridges is *not very distinct*," clearly implying that in that specimen there is a median division: other teeth are, however, described as showing no trace of this cleft. It is quite true that the mesial cleft is very indistinct in the upper true molars of *S. cliftii*, but it appears to me from an examination of the cast of Clift's specimen, and other molars in the Indian Museum, that there is almost or quite as much trace of this median cleft in them as in the Chinese tooth; it may also not be improbable that this cleft is more distinct in the earlier teeth, which not unfrequently show ancestral characters more distinctly than the later ones. There now, therefore, only remains the question of the curvature of the ridges. Professor Owen, in describing the Chinese tooth, himself admits that he has observed a curvature of the ridges in certain specimens of the molars of *S. bombifrons*, and this curvature will be subsequently shown to occur occasionally in molars both of that species and of *S. insignis*. If, therefore, a curvature may occasionally occur in the ridges of the molars of one species of *Stegodon* which are normally straight, there appears to be no valid reason why it should not equally well occur in those of another.

Since, therefore, in my opinion, there seems to be no character by which the Chinese milk-molar can be distinguished from the molars of *S. cliftii*, and since the milk-molar agrees with the true molars of that species in the manner of wear of the ridges, and in having a low ridge-formula, there appears to me to be every probability that the Chinese tooth is really the second upper milk-molar of *Stegodon cliftii*. If this interpretation be correct, the name of *S. sinensis* must be expunged, and the distribution of *S. cliftii* be extended to China. As a character of perhaps minor import the Chinese tooth agrees with the first true molar of *S. cliftii* in having a large number of cusps on the ridges, and in the worn enamel being much crenulated.

Third upper milk-molar.—The tooth represented in fig. 1 of Plate XLV, collected by Mr. Theobald in the Punjab, is a left upper molar of a *Stegodon*, which I formerly[1] considered as the first true molar of *S. bombifrons*, but which, as will be seen below, I now find cannot belong to that species. The tooth is considerably worn and carries six ridges and a large hind-talon; from the number of ridges this tooth cannot belong to *S. insignis* or *S. ganesa*, in which the two first "intermediate" molars never carry less than seven ridges each (*vide infra*). There now, therefore, only remains *S. cliftii*, to which the specimen can belong; but before going further, it will be well to describe the specimen. The two first ridges of the specimen are so worn that their dentine surfaces have become united, and a trace of the enamel of the first valley remains only on the inner side. The remaining four ridges are also well worn; they extend straight across the crown, and their outer is slightly

[1] Rec. Geol. Surv. of India, Vol. XI, p. 74.

higher than their inner sides; they are, however, so much worn that the exposed dentine surfaces have almost the same width throughout. The fifth and sixth ridges show traces of two constrictions. The hind-talon is just perforated by wear. The crenulations of the enamel show that the ridges carried a considerable number of cusps; while the extremities of the ridges show that they were low and broad. The length of the tooth is 4·9 inches and its greatest width 2·9 inches.

In all the above characters, as well as in its great proportionate width, the tooth agrees with the first true molar of *Stegodon cliftii*: and I have little doubt that it belongs to that species. It is true that the first true molar of *S. cliftii* has no hind-talon; the second true molar of that species, however, has a large hind-talon,[1] the absence or presence of which must accordingly be considered as of no importance. It now only remains to consider the serial position of the tooth. If we turn to the posthumous description of the plates of the "Fauna Antiqua Sivalensis,"[2] we shall find that the first upper true molar of *S. cliftii* has a length of 6·1 and a width of 3·3 inches. The Punjab tooth must consequently be the last milk-molar, as it is so much smaller than the first true molar: all the previously known teeth of the species are of unusually large size, in which respect the second and third milk-molars agree with them. The third milk-molar of this species, in having six ridges, accords with the prediction of Dr. Falconer that such would probably be the case when the tooth was discovered. This tooth agrees with the Chinese second milk-molar in the crenulations of the exposed ridges of the enamel.

A specimen of the palate of *Stegodon cliftii* figured in Plate XXX, fig. 1, of the "Fauna Antiqua Sivalensis" shows a very much worn third milk-molar, the ridges of which have been completely ground down. The length of this fragmentary tooth is 3·3 inches and its width 2 inches, but when complete, it must have been much larger, and would probably then have agreed in size with the tooth which I have described above.

First upper true molar.—As we have already seen, a complete specimen of the first upper true molar of *Stegodon cliftii* is represented in fig. 2 of Plate XXX of the "Fauna Antiqua Sivalensis," and is described in the following words by Dr. Falconer: "This is the first or antepenultimate true molar, upper jaw, left side, entire, detached, and beautifully preserved. It has six ridges and a small hind-talon. The tooth is nearly oblong. The enamel is somewhat fluted, and there is very little cement. There is very little convexity of the tooth across, and no distinct indication of the mesial dividing line. There are as many as eleven to twelve denticles or points (cusps). The tooth is compressed and angular in front, and the three front ridges are worn. This tooth is also represented in fig. 6 (Plate XXXIX) of Mr. Clift's memoir. It is there described as *Mastodon elephantoides*. Its elephantine affinities are indicated by the absence of a longitudinal line of division along the crown, and by the greater number of points (cusps) that enter into the composition of the ridges. Length 6·1, width in front 3·, width behind 3·3 inches."

[1] F. A. S., Pl. XXX, fig. 3. [2] *Ibid.*, p. 42 (Index).

Second upper true molar.—Two specimens of the second upper true molar of this species are represented in fig. 3 of the above quoted plate of the "Fauna Antiqua Sivalensis" and are described as follows: "Superb palate specimen containing the penultimate true molar *in situ* on both sides. The tooth is proved to be the penultimate by its large dimensions, and by the circumstance that two or three ridges of another tooth (third true molar) are seen behind it. The crown ridges are all more or less worn and partly damaged by fracture, but enough remains to show that the tooth was composed of six ridges and a hind-talon. The palate is very flat, and the teeth on either side (in the erect position of the skull) slope upwards from without inwards. The teeth have very little cement. The slope of the grinding surface from without inwards is a mastodontoid character. In *Elephas* (*Stegodon*) *insignis* the tendency of the grinding surface is to shelve upwards from the inside outwards. Length of molar 8·2 inches, width 4· inches."

A very similar specimen to the above is exhibited in the Indian Museum, collected by Mr. Theobald in the Hushiarpúr district. The penultimate molar in that specimen is well worn, and carries six straight and low ridges, and a hind-talon. The tooth, except in the matter of size, agrees in every detail with Falconer's specimen. Its length is 7·3 inches, and its greatest width 3·8 inches.

Third upper true molar.—Several specimens of the last upper molar of *S. cliftii* are contained in the collection of the Indian Museum, all of which have been obtained from Burma. They carry either seven or eight ridges and a hind-talon, and agree in general characters with the teeth noticed above. One of these specimens is described by Dr. Falconer on page 113 of the first volume of the "Palæontological Memoirs," from which the following extracts are taken: "The plane of wear slopes obliquely from the outside inwards, so that the interior side of the first three ridges is ground down much lower than the outer side. There is no mark of a longitudinal line bisecting the tooth, as in the true *Mastodons*, into an outer and inner division. The ridges are a little convex in front and concave behind, determining a similar form to the valleys between them, which run across without any interruption. The mammillæ are obtuse and closely packed, and nine or ten of them may be counted on each ridge. Hardly any crusta petrosa (cement) is visible, except between the fifth, sixth, and seventh ridges. Length of molar 9·3 inches; greatest width 4·3 inches."

Last lower true molar.—I cannot find any record of any of the lower molars of *Stegodon cliftii*, with the exception of the last true molar, of which a specimen from Burma is represented in fig. 5 of Plate XXX of the "Fauna Antiqua Sivalensis," described by Dr. Falconer as follows: "Last true molar, lower jaw, left side, consisting of eight ridges and a talon. Five ridges are touched by wear, and the two anterior ridges are nearly worn out. The crown is very flat; the points (cusps) are large and few in number, and there is no very distinct mesial dividing line (and) but little cement. Length 12·7 inches, width 4·5 inches."

Another specimen of the same tooth, collected by Mr. Theobald in the Siwaliks

of the Punjab, has been already referred to by me in the "Records," as noticed above. That tooth carries seven ridges, each of which has only a small number of cusps, and exhibits a slight trace of a mesial cleft, with the plane of wear sloping from the inner to the outer side. It seems from these two specimens that the lower molars of *S. cliftii* carry a smaller number of cusps than the upper.

Conclusion.—The skull and complete mandible of *S. cliftii* are unfortunately still unknown, and we must, therefore, depend entirely on the teeth for its specific characters. The whole of the upper molar series, with the exception of the first milk-molar, are now known, while of the lower molars only the last is known. The ridge-formula of the species may probably be represented as follows:—

$$\overset{\text{Milk-molars.}}{\frac{?+4+6}{?+4?+6?}} + \overset{\text{True molars.}}{\frac{6+6+(7-8)}{6?+6?+(7-8)}}$$

Species 2: Stegodon bombifrons, Falconer & Cautley. Plates XLV, fig. 3, XLVI, figs. 1 & 3.

History.—The first mention that I can find of *Stegodon bombifrons* occurs in the Introduction to the "Fauna Antiqua Sivalensis,"[1] where the name only is mentioned. Further on in the same work[2] mention is made of the cranium of the species, and some of the characters of the molars are pointed out. The molars are said to differ from those of *S. insignis* (*vide infra*) in having broader and less elevated ridges, and more open valleys, and by the number of ridges being fewer, though greater than in *S. cliftii*. In Plates XXIXA & B of the same work various specimens of the molars are figured, showing that the last upper milk-molar had six ridges, and the corresponding lower tooth either five or six ridges, while other specimens of the "intermediate" molars had seven ridges, and the last lower molar never carried more than nine ridges. In the "Records"[3] I alluded to a six-ridged tooth, which I then thought to be the first upper true molar of *S. bombifrons*, but which, as noticed above, I now find probably belongs to *S. cliftii*; the corresponding tooth referred to on the same page of the "Records" as belonging to the so-called *S. sinensis* of Professor Owen I now find belongs to the present species.

Molar series.—With these preliminary remarks, I will now consider in serial order such of the molar teeth of this species as are at present known to me.

First milk-molars.—Of the first milk-molar, either of the upper or lower jaw, I can find no specimen.

Second upper milk-molar.—Of the second upper milk-molar I likewise cannot find any specimen.

[1] "Palæontological Memoirs," Vol. I, p. 20.
[2] *Ibid.*, p. 81.
[3] Rec. Geol. Surv. of India, Vol. XI, p. 73.

Second lower milk-molar.—Of the second lower milk-molar of *S. bombifrons* there is no specimen figured in the "Fauna Antiqua Sivalensis," neither is any mention of this tooth made in any of Falconer's subsequent memoirs. The specimen represented in Plate XLVI, fig. 3, of this memoir, is undoubtedly the second lower milk-molar of a *Stegodon,* and in all probability of *S. bombifrons.* It was obtained by Mr. Theobald in the Siwaliks of the Punjab. The tooth is a germ specimen of the crown, entirely untouched by wear: it is much narrower in front than behind, and very concave on one side, from which characters I infer that the tooth belonged to the lower jaw. The concave side will be the outer, and the tooth will consequently belong to the left ramus of the mandible. Its size proves it to be a second milk-molar, while the unbroken transverse ridges, with very little cement, shows that it must belong to a *Stegodon.*

This tooth carries four complete transverse ridges, increasing in width regularly from the first to the last. There is a very small anterior talon carrying two cusps, and a larger posterior talon, the number of cusps on which is concealed by matrix. The first ridge carries six cusps, and the second seven: the number of cusps on the two succeeding ridges cannot be clearly ascertained. The two first ridges are not quite straight; each ridge is low and blunt, and very broad at the base: cement is present in the valleys in small quantities. The central point of each ridge is the highest. In the following table the dimensions of this tooth are compared with those of the second lower milk-molar of *Stegodon insignis,* which will be described in the sequel.

	S. bombifrons.	*S. insignis.*
Length of tooth	2·2	2·7
Width of first ridge	1·0	1·05
Ditto of last ditto	1·4	1·55
Height of last ditto	0·7	1·05
Antero-posterior diameter of base of ridge	0·5	0·5
Interval between summits of penultimate and last ridges	0·46	0·35

From this table it will be seen that the tooth under consideration differs from the corresponding milk-molar of *S. insignis* (including *S. ganesa*) by the ridges being lower and wider, and placed farther apart from one another. The two teeth further differ in that the second lower milk-molar of *S. insignis* has a larger quantity of cement, and five in place of four ridges (see below). In its smaller number of ridges and in their form the Punjab tooth agrees with the characters of the molars of *S. bombifrons* as given by Falconer, and I have, therefore, no doubt in referring it to that species.

The second upper (and probably therefore the corresponding lower) milk-molar of *Stegodon cliftii* (see above, and Plate XLV, fig. 2) corresponds, as far as regards the number of ridges carried by the crown, with the corresponding tooth of *S. bombifrons,* but is distinguished, among other characters, by one side of each ridge being higher than the other, by the still greater thickness of the ridges, as well as by the form of the anterior talon, and the greater size of the whole tooth.

Third upper milk-molar.—I have no complete specimen of the third upper milk-molar, though an incomplete specimen of this tooth will be noticed when I come to the first upper true molar.

Third lower milk-molar.—Two much-worn and somewhat mutilated specimens of the third lower milk-molar of *Stegodon bombifrons* are figured in the "Fauna Antiqua Sivalensis" (Plate XXIXA, fig. 1, Plate XXIXB, fig. 5). The first of these teeth carries six ridges and a talon, and has a length of 4 inches, and a width of 2 inches. The second carries five ridges, and fore-and-aft talons, and has a length of 3·6 inches and a width at the widest point of 1·8 inches. No description of these teeth has ever appeared.

In fig. 3 of Plate XLV of this memoir I have had drawn a perfect specimen of a tooth which certainly appears to be the third lower milk-molar of the right side of *Stegodon bombifrons*. This tooth is now in the Indian Museum, and was obtained by exchange with the Lahore Museum. It was found in the Siwaliks of the Punjab. The crown carries five transverse ridges, and two small talons, the most anterior one being somewhat broken. The first three ridges are worn, but the two last are still untouched by attrition.

The penultimate ridge carries about nine cusps. The ridges are very low and blunt, and there is but a small quantity of cement in the valleys. The dimensions of the specimen are as follows:—

Length	4·1
Width of first ridge	1·7
Ditto of penultimate ridge	2·2
Height of ditto ditto	1·1
Antero-posterior diameter of base of penultimate ridge	0·75
Interval between summits of penultimate and ante-penultimate ridges	0·75

The unworn ridges are lowest at their centres; the two first ridges have a slight obliquity in the plane of wear, which slopes from the inner to the outer side: in the third ridge, which is less worn, and in the two unworn ridges, the centre of each ridge is the lowest point, showing that the tooth cannot belong to *S. cliftii*. In its blunt ridges, low ridge-formula, and small quantity of cement, the tooth presents all the characters of the molars of *Stegodon bombifrons*. It will be seen below that the corresponding tooth of *Stegodon insignis* carries a larger number of ridges, which are also thinner and taller. The corresponding tooth of *S. cliftii* is unknown, but its ridges would probably be considerably higher on the inner than on the outer side, and the whole tooth would also be wider than the specimen under consideration. The figured tooth seems to agree very closely with the five-ridged tooth figured by Falconer, but is of slightly larger size, and the hind-talon relatively rather smaller.

It seems that the third lower milk-molar of *Stegodon bombifrons* may have either five or six ridges, and it is therefore inferred that the corresponding upper tooth, when discovered, will present either one or both of these numbers.

First upper true molar.—There is no specimen of the first upper true molar of *Stegodon bombifrons* figured in the "Fauna Antiqua Sivalensis," neither do any of the crania of that species in the Indian Museum contain this tooth.

The six-ridged tooth represented in fig. 1 of Plate XLVI of this memoir, is I think, in all probability, from its low ridge-formula, the first upper true molar of *Stegodon bombifrons;* the tooth certainly does not belong to *S. cliftii,* and I cannot find any instance of the corresponding tooth of *S. insignis* carrying less than seven ridges; moreover, the ridges are rather lower in the figured specimen than in the corresponding tooth of *S. insignis.*

The figured tooth is the specimen referred by me to *Stegodon sinensis* in the "Records."[1] This determination was made from the curvature of the ridges, before I found that this was a valueless character, and before I had obtained the cast of the tooth on which the Chinese species was founded by Professor Owen.

The figured tooth was obtained by Mr. Theobald in the Kangra district, and is implanted in a fragment of the left maxilla, which also contains the much-worn last milk-molar. The crown of the tooth carries six complete ridges, and a large anterior talon. The first four ridges are worn, while the two last are still intact. The penultimate ridge carries twelve or thirteen tubercles, and, like the other ridges, has its highest point in the centre. The first three ridges are nearly straight; but the three last are much curved. One of the tubercles of the last ridge is placed considerably in advance of the others. There is a slight trace of a median division in the first two ridges. The length of this tooth is 5·9 inches, its greatest width 3 inches, and the height of the penultimate ridge 1·6 inches.

The height of the ridges in this tooth is slightly less than is generally the case with those of the corresponding tooth of *Stegodon insignis,* though the ridges in some specimens of the latter are not higher than in the present specimen. It is therefore only from the low ridge-formula that I consider it probable that this tooth belongs to *S. bombifrons,* in which we know that the last molar has a lower formula than in *S. insignis.* Another very similar tooth in the Indian Museum, which I also refer to *S. bombifrons,* has six ridges, but no trace of a hind-talon. From the convexity of the ridges the figured tooth cannot belong to *S. cliftii,* of which the first true molar has been already described.

The last milk-molar in the same jaw is worn away to such an extent that only the two last ridges are differentiated from the common surface of dentine to which the others have been reduced. Still, however, from the shape of the crown of this tooth, I am nearly certain that it could not have carried more than either five or six ridges, in which case the jaw may pretty safely be referred to the present species, as the last milk-molar of *S. insignis* never has less than seven ridges.

I have figured this tooth chiefly to show that a great degree of curvature may occur in the ridges of species of *Stegodons,* which are usually quite straight. In the

[1] Rec. Geol. Surv. India, Vol. XI, p. 73.

penultimate upper true molar of a cranium of *S. insignis*[1] in the Indian Museum, the ridges are still more curved than in the present specimen.

First lower true molar.—The two lower molars of a *Stegodon* represented in Plates XXIXA, fig. 2, and XXIXB, fig. 6, of the "Fauna Antiqua Sivalensis," are classed by Dr. Falconer as the first true molars of *Stegodon bombifrons*. Each of these teeth carries seven low broad ridges and a talon. These teeth carry one ridge more than the corresponding upper molar, and the same number as the corresponding tooth of *S. insignis*.

Second upper true molar.—In the Indian Museum there are two palate specimens of a *Stegodon*, with the nearly complete penultimate molars, each of which carries seven ridges and a talon. These ridges are thick and low, and the valleys have but little cement. In the smaller specimen the ridges are quite straight, but in the larger they are bent and irregular, like those of the first upper molar described above. From the breadth and lowness of the ridges there is no doubt but that these teeth belong to *S. bombifrons*. The corresponding tooth of *S. insignis* has nearly always eight ridges, which are much higher, and which contain more cement in the valleys. The length of the tooth in the smaller specimen is 7·4 inches, and its greatest width 3·4 inches; in the larger specimen the length of the corresponding tooth is 8·3 inches, and its greatest width 3·9 inches. The teeth are much worn and somewhat broken, and are not, therefore, calculated to afford a good figure.

Second lower true molar.—A second lower true molar of this species is figured by Falconer in Plate XXIXA, fig. 3, of the "Fauna Antiqua Sivalensis." That tooth carries seven ridges and a hind-talon, the front one having probably been worn away. The ridges are low and blunt, and seem to carry but few cusps. A corresponding tooth in the Indian Museum shows the same number of ridges, and small fore-and-aft talons. The ridges are much lower and blunter than those of the corresponding tooth of *S. insignis*, in the same collection, and the valleys contain much less cement. The tubercles on the two last ridges are only five or six in number, while those on the corresponding ridges of the tooth of *S. insignis* carry eight or nine. The length of the second lower molar of *S. bombifrons* is 7·7 inches, and its greatest width 3·3 inches. The tooth being somewhat battered would not afford a good figure; Falconer's figure, though on a small scale, is, however, amply sufficient to distinguish this tooth.

Third upper true molar.—The cranium figured in Plates XXVII and XXVIII of the "Fauna Antiqua Sivalensis" exhibits the last true molar of the present species. The tooth of either side carries nine ridges and a talon; its length is 10·2 inches and its width 3·4 inches. The antero-internal extremities of the molars in this cranium are only separated by an interval of 1 inch; another skull in the

[1] This cranium (No. $\frac{S}{4}$) is described by Dr. Falconer at page 41 of the "Catalogue of the Fossil Vertebrata in the Museum of the Asiatic Society of Bengal." No notice is, however, taken of the curvature of the ridges, probably showing that the author thought it a point of no importance.

Indian Museum, in which the last molars carry eight ridges and a hind-talon, shows that this extreme approximation of the molars is due to lateral crushing, since in the latter skull the antero-internal angles of the molars are separated by more than 2 inches.

Third lower true molar.—Specimens of the last lower molar of this species are represented in Plate XXIX A (fig. 8) and XXIX B (fig. 7) of the "Fauna Antiqua Sivalensis," showing that this tooth carried nine ridges and a hind-talon.

Ridge-formula.—From the foregoing details of the teeth of *Stegodon bombifrons*, their ridge-formula may be approximately represented as follows:—

Milk-molars.	True molars.
$\frac{?+4?+(5-6)?}{?+4+(5-6)}$	$\frac{6+7+(8-9)}{7+7+9}$

This formula will be seen to be intermediate between the formulæ of *S. cliftii* (see above) and *S. insignis* (see below). The last milk-molar in some cases presents a lower number of ridges than in *S. cliftii*, while the true molars have generally a higher number than those of the latter. The last true molar of *S. bombifrons* has always a smaller number of ridges than the corresponding tooth of *S. insignis*, while the two preceding teeth present, on the whole, a smaller number of ridges, though the highest number of ridges (seven) which occurs in the teeth of *S. bombifrons* equals the lowest which occurs in those of *S. insignis*.

Cranium.—A very perfect cranium (now in the British Museum) is figured in Plates XXVII and XXVIII of the "Fauna Antiqua Sivalensis," and another less perfect specimen (also in the British Museum) in the preceding plate of the same work. A third cranium, lacking a portion of the left frontal region, is in the collection of the Indian Museum, obtained by Mr. Theobald in the Siwaliks of the Kangra district. This specimen, though of rather smaller size, agrees precisely in form with the British Museum specimens, so that this form of cranium may be considered as characteristic of the species. The characters of the skull, as given by Falconer, are as follows: The skull "is convex from occiput to front, and also across, and is very narrow at the temporal contraction. The bounding ridges sweep round by a bold curve into the post-orbitary processes, as in *E. meridionalis*. There is a deep furrow between the tusks (which are of small size). The nasal opening for the trunk is above the line (or nearly so) of the post-orbitary process of the frontal bone. Above the infra-orbitary foramen on the right side there is another small opening."

Distribution.—Remains of this species have not, as far as I am aware, been found elsewhere than in the sub-Himalayan Siwaliks, and I doubt if they occur to the west of the Jhelam river.

SPECIES 3: STEGODON INSIGNIS, Falconer & Cautley. Plates XLV, fig. 4, XLVI, figs. 2 & 4.

Synonym; (?) *S. orientalis*, Owen.

History.—The first figured tooth of this species seems to be the specimen obtained from Ava, and figured by Mr. Clift in the "Transactions of the Geological Society of London,"[1] under the name of *Mastodon elephantoides.* Dr. Falconer subsequently showed[2] that the latter name really comprehended more than one species, and gave to the teeth with a high ridge-formula the name of *Elephas* (*Stegodon*) *insignis.* Several skulls and a large series of teeth appear under that name in the "Fauna Antiqua Sivalensis." In the same work a considerable number of teeth also appear under the name of *Elephas* (*Stegodon*) *ganesa:* these latter teeth, however, cannot be distinguished from those named *Stegodon insignis,* and as we shall see subsequently, it is only the adult skulls of these two very closely allied species that can be distinguished. The molars of *Stegodon insignis* also bear a very close resemblance to those of *S. bombifrons,* but are distinguished by a generally higher ridge-formula, and by the ridges being narrower and taller, as well as by the greater amount of cement which is usually present on them. Dr. Falconer[3] considers that the following formula represents the average number of the ridges of the molars of this species, though he remarks that there is a greater tendency to variation in this respect than there is among the true *Mastodons.* Dr. Falconer's formula is as follows:—

$$\overset{\text{Milk-molars.}}{\frac{2+5+7}{2+5+7}} = \overset{\text{True molars.}}{\frac{7+8\quad+\quad(10-11)}{7+(8-9)+(11-13)}}$$

We shall subsequently see that this formula only requires very slight alteration as far as our present knowledge goes. As a very large series of the teeth of this species are figured in the "Fauna Antiqua Sivalensis," I have only thought it necessary in this memoir to figure a few specimens of the milk-molar dentition, which exhibit well the general dental characters of the species, as distinguished from *S. bombifrons.*

First milk-molars.—Of the first milk-molars of *Stegodon insignis* I know of no perfect specimens, though a fragment of the upper tooth is attached to the young maxilla represented in Plate XIX, fig. 1, of the "Fauna Antiqua Sivalensis."

Second upper milk-molar.—Of the second upper milk-molar of this species two specimens are represented in the "Fauna Antiqua Sivalensis;" one in fig. 1 of Plate XIX and the other in fig. 3 of Plate XXIX (misnamed in plate *S. bombifrons*). The first of these teeth is complete and well worn; it exhibits five complete ridges, in front a large talon or incomplete ridge, and behind a small talon. The

[1] Ser. 2, Vol. II, Pl. XXXVIII, fig. 2.
[2] Pal. Mem., Vol. II, p. 85.
[3] *Ibid.*, p. 86.

ridges are straight, fairly broad, and appear to have carried a large number of cusps on their unworn summits; the number of cusps on the yet unworn last ridge seems to be twelve. The tooth is considerably narrower in front than behind; its length is 2·7 inches and its greatest width 1·6 inches: the width of the base of the central ridge being ·6 inch.

On page 43 of the "Catalogue of the Fossil Vertebrata in the Museum of the Asiatic Society of Bengal," Dr. Falconer describes a second upper milk-molar of an elephant (No. S. 7) as belonging to *S. insignis*. This identification appears to me to be a mistake; the tooth really belonging to *Loxodon planifrons*. The tooth differs from both the second upper molars of *Stegodon insignis* figured in the "Fauna Antiqua Sivalensis," by being less narrowed in front, by the ridges being six in number, by their being narrower and higher, by the number of cusps on the last ridge being only five or six, by there being no hind-talon, and by the much greater quantity of cement present in the valleys, which completely overlaps the last unworn ridge. In all the above-mentioned points this tooth agrees with the teeth of *Loxodon planifrons*, and in the Indian Museum, where it is now deposited, it has accordingly been classed as belonging to that species.

Stegodon orientalis, Owen.—The fragment comprising the two last ridges and the hind-talon of a (probably) last upper milk-molar of a *Stegodon* from China, figured and described by Professor Owen in the "Quarterly Journal of the Geological Society of London"[1] as the second upper milk-molar of a new species of the genus, under the name of *S. orientalis*, does not appear to me to be sufficiently distinguished from the corresponding tooth of the present species.

Professor Owen, in describing the Chinese milk-molar, and a fragmentary true molar, which he also refers to the same species, lays great stress on the number of cusps carried on the ridges of these teeth, which in the larger tooth he estimates at about a dozen. Now, I have already shown elsewhere[2] that there is a considerable tendency to variation in the number of cusps carried by the ridges of the molars of *Stegodon ganesa* and *S. insignis*, and in the last lower milk-molar of the latter species represented in fig. 4 of Plate XLVI of this memoir, some of the ridges carry at least seventeen cusps, a greater number than occurs in the larger Chinese tooth. Again, the figured third lower milk-molar of *S. insignis* in two of its ridges exhibits a most distinct median cleft, which character Professor Owen considers distinctive of his Chinese specimen. If the figure of the latter be compared with the figure of the second upper milk-molar of *S. insignis*, given in fig. 1 of Plate XIX of the "Fauna Antiqua Sivalensis,"[3] it will be seen, as far as can be gathered from the small size of the latter figure, that the two teeth have very much the same general form and size. The Chinese tooth cannot belong to *S. cliftii*, as its ridges are too tall, are highest in the middle, and carry too much cement. The ridges of

[1] Vol. XXVI, p. 421, Pl. XXVIII, figs. 3 and 4.

[2] Rec. Geol. Surv. India, Vol. IX, p. 49.

[3] The corresponding tooth of the same species represented in fig. 3 of Plate XXIX of the Fauna Antiqua Sivalensis (wrongly referred in plate to *S. bombifrons*) is somewhat broader posteriorly.

the Chinese tooth are likewise too high for *Stegodon bombifrons*. Although it may not be a matter of complete certainty until we obtain the entire Chinese milk-molar, it appears to me that there is every probability that that tooth is really the second upper milk-molar of *Stegodon insignis*, and that the imperfect true Chinese molar referred by Professor Owen to his new species, *S. orientalis*, also belongs to *S. insignis*.

Second lower milk-molar.—Of the second lower milk-molar of *Stegodon insignis*, two imperfect specimens are represented in figs. 1 and 3 of Plate XX of the "Fauna Antiqua Sivalensis;" their distinctive characters are not, however, very well displayed, neither is there any description of these teeth in the explanation of the plates. To give a good idea of this tooth, I have had drawn in fig. 2 of Plate XLVI, a very nearly perfect specimen from the collection of the Asiatic Society of Bengal, now in the Indian Museum. The tooth was determined by Dr. Falconer, and a short notice of it will be found on page 44 of his Catalogue of the Fossil Vertebrata in the Museum of the Society. The specimen is implanted in a fragment of the left ramus of the mandible, and has been somewhat damaged anteriorly; most of the ridges have been well worn, but of the last only the summits of the cusps are touched by wear. The crown of the tooth is considerably narrower in front than behind, and carries five ridges (the anterior broken) and a small hind-talon. Relatively to the corresponding tooth of *Stegodon bombifrons*, which has been already described, the ridges are high and slender; there is a considerable quantity of cement in the intervening valleys, and the enamel is thrown into deep vertical groovings and puckerings. The last unworn ridge carries ten cusps. The length of this tooth is 2·7 inches, its greatest width 1·6 inches, and the height of its ridges 1 inch. The important points in which this tooth differs from the corresponding tooth of *Stegodon bombifrons* have been already sufficiently pointed out when describing the dentition of that species.

Third upper milk-molar.—Of the third upper milk-molar of *Stegodon insignis*, specimens are figured in the "Fauna Antiqua Sivalensis," Plates XIX, figs. 2 and 3, and XIX A, fig. 1, which show that this tooth carried seven ridges and small fore-and-aft talons. The very perfect tooth of a *Stegodon* represented in Plate XLV, fig. 4, of the present memoir agrees with the last-mentioned specimens in the characters referred to, and as its other characters are also those of the molars of *S. insignis*, it has been classed as the third upper milk-molar of that species. The tooth was collected by Mr. Theobald in the Siwaliks of the Punjab: only its two first ridges have been affected by attrition, but portions of the summits of most of the others have unfortunately been broken away. The tooth is narrower in front than behind, and, as before indicated, carries seven ridges,[1] and very small fore-and-

[1] The last ridge is smaller than the others, and might be reckoned as a talon, but that it carries a still smaller ridge behind. This last ridge is evidently a talon in process of passing into a true ridge. The hind-talon in the tooth drawn in fig. 1 of the same plate will be seen to be relatively shorter in proportion to the true ridges, and is evidently only a large talon. It will, of course, be seen that the distinction is really an arbitrary one.

aft talons. The anterior talon is connected by a longitudinal ridge with the inner extremity of the first true ridge. Each transverse ridge is tall and slender, and is highest along the median line; there is an indistinct trace of a longitudinal median cleft across the anterior ridges. Owing to the broken condition of the summits of the ridges, it is not easy to estimate the precise number of cusps borne by each, but they appear to be from thirteen to fifteen. The last ridge is more closely approximated to the penultimate, than is the latter to the antepenultimate. The hind-talon merely forms a kind of ledge on the last ridge. Both these characters are shown in Falconer's specimen. The length of the specimen is 4·6 inches, its greatest width 2·4 inches, and the height of the central ridge 1·3 inches. The number and height of the ridges, together with the great number of cusps borne on them, are distinctive characters of the dentition of *Stegodon insignis* as opposed to *S. bombifrons*.

Third lower milk-molar.—Of the third lower milk-molar of the present species, two imperfect specimens are represented in figs. 1 and 2 of Plate XX of the "Fauna Antiqua Sivalensis"; one of these shows that the tooth has seven ridges. In Plate XLVI, fig. 4, of the present memoir, I have had figured a quite complete specimen of this tooth, obtained by Mr. Theobald in the Siwaliks of the Punjab. This very beautiful specimen is implanted in a fragment of the right ramus of the mandible, which also contains the two last ridges of the penultimate milk-molar. The figured tooth is oblong in shape, and nearly as wide in front as behind : its outer border is concave and its inner convex. The crown carries seven ridges and fore-and-aft talons. Only the first and second ridges have been affected by wear; the ridges are tall and slender, and bear a large number of cusps on their summits; thus the fourth ridge carries no less than seventeen cusps, a considerably larger number than occurs in the so-called *Stegodon orientalis* of Professor Owen, referred to above. The anterior talon is closely applied to the first ridge; the posterior talon forms a small distinct ridge, carrying five large cusps. The length of the tooth is 4·9 inches, and its greatest width 2·1 inches. Another similar specimen of this tooth, also from the Punjab, is contained in the collection of the Indian Museum : from this we may fairly infer that the number of ridges in this tooth is generally constant. The tooth is widely different from the corresponding tooth of *S. bombifrons* described and figured above (Plate XLV, fig. 3); the distinctive points are the greater number of the ridges, their thinner and more elongated form, and the greater number of cusps which they carry on their summits.

First upper true molar.—Of the true molar series of *Stegodon insignis*, a very large number of teeth are figured in the "Fauna Antiqua Sivalensis," and I have, therefore, thought it unnecessary to figure any in this memoir, and have contented myself with merely noticing the salient points of each tooth. A specimen of the first true molar is shown in the skull depicted in fig. 4 of Plate XIX of the above-mentioned work. It carries seven ridges and a talon; the ridges are high, and the valleys well filled with cement; each ridge carries a large number of

cusps.[1] Of two young skulls in the Indian Museum containing the third milk- and the first true molars, the first true molar in the one carries seven ridges and two talons, and has a length of 5·7, and a width of 2·6 inches, while in the other the corresponding tooth has eight ridges with a length of 6·5, and a width of 2·9 inches. A specimen of a skull from the Asiatic Society of Bengal, now in the Indian Museum, has seven ridges in the first true molar. It would appear, therefore, that while seven is the normal number of ridges in this tooth, this number may occasionally be increased to eight.

First lower true molar.—Of the first lower true molar a worn specimen in the Indian Museum seems to have seven ridges, and has a length of 5·2 inches, with a breadth of 2·8 inches ; a very similar specimen also carries the same number of ridges. A specimen of the first lower true molar of this species represented in fig. 4 of Plate XXV of the "Fauna Antiqua Sivalensis" also has seven ridges and a hind-talon. As far, therefore, as is at present known, seven seems to be the constant number of ridges in this tooth.

Second upper true molar.—A specimen of the second upper true molar represented in fig. 5 of Plate XIX of the "Fauna Antiqua Sivalensis" exhibits eight ridges and a front talon: another specimen in fig. 4 of the succeeding plate of the same work has also eight ridges, with fore-and-aft talons. A cranium described on page 41 (No. S. 4) of Dr. Falconer's "Catalogue of the Fossil Vertebrata in the Museum of the Asiatic Society of Bengal," and now in the collection of the Indian Museum, exhibits the first and second true molars, the latter of which has only seven ridges; the penultimate tooth in the same skull has only six ridges, but an anterior ridge may have disappeared in wearing. In the skull figured in fig. 2 of Plate XIXA of the "Fauna Antiqua Sivalensis," there are only seven ridges in the penultimate true molars. Other specimens of the second upper molar of *S. insignis* in the Indian Museum exhibit eight ridges. Eight may, therefore, be taken as the normal number of ridges in this tooth, with seven as an occasional variety.

Second lower true molar.—Three perfect specimens of the second lower true molar of *Stegodon insignis* in the collection of the Indian Museum exhibit respectively, eight ridges and two talons. Two specimens of this tooth represented in figs. 4 and 9 of Plate XX of the "Fauna Antiqua Sivalensis". exhibit, respectively, nine and ten ridges. Another specimen figured in the same work has seven ridges (Plate XXA, fig. 2, *S. ganesa*); while yet another (Plate XXIVA, fig. 3) has upwards of twelve ridges. The specimen drawn in Plate XXXVIII, fig. 2, of Clift's memoir, has nine ridges and a large hind talon. Eight or nine may therefore be taken as the normal number of ridges in this tooth, with occasional variations from seven to twelve.

Last true molars.—The number of ridges in the last upper true molar seems to vary from ten to eleven, and in the lower from eleven to thirteen.

[1] The tooth figured in Plate XXIV, fig. 1, of the Fauna Antiqua Sivalensis as the first true molar of *S. ganesa*, has only six very broad ridges, with few cusps, and probably belongs to *S. bombifrons*.

Conclusion.—From the above descriptions the ridge-formula of this species may be tabulated as follows:—

$$\frac{2+5+7}{2+5+7} = \frac{(7-8)+(7-\ 8)+(10-11)}{7\ \ +(7-12)+(11-13)}$$

The ridge-formula of this species is constant, as far as we at present know, in the milk-molar series, but is liable to very considerable variations in the true molar series. In the succeeding sub-genera (*Loxodon*, *Euelephas*), it will be found that this variability extends back into the milk-molar series, which seems to be the most constant in its ridge-formula. In *Stegodon insignis* the number of cusps on the ridges seems to be greatest in the milk-molar series, sometimes attaining as many as seventeen, while in the second true molar, according to Dr. Falconer, ten seems to be the average number.

Cranium.—The adult cranium of this species is remarkable for the peculiar flattened form of the vertex, from which character it derives its specific name; a further discussion on the skull will be found under the head of the next species. Dr. Falconer mentions as a character of this species the great height of the pterygoids, which form a ridge running up to the base of the orbits. The lower jaw is much like that of the Indian elephant in general shape; the rami, however, diverging to a greater extent posteriorly.

Distribution.—Remains of this species has been obtained from the Siwaliks, and not improbably from the Narbada gravels.

SPECIES 4: STEGODON GANESA, Falconer & Cautley.

History.—This fourth species of Siwalik *Stegodon* appears to have been mainly founded on an imperfect cranium with long tusks, presented by the late Colonel Baker to the British Museum. This cranium is represented on Plates XXI and XXII of the "Fauna Antiqua Sivalensis," and in a restored state on Plate XXIII of the same work.

Distinctness of the species.—Subsequently to the publication of the "Fauna Antiqua Sivalensis," Dr. Falconer[1] seems to have had considerable doubts as to the specific distinctness of this cranium, and to have thought that it might be merely a variety of *Stegodon insignis.* This conclusion appears to have been arrived at because no distinction could be found between the molars of *Stegodon insignis* and *S. ganesa*, and also because there appears to be somewhat of a transition from the typical form of the cranium of *S. insignis* (F. A. S., Plate XV) towards that of *S. ganesa.* The typical cranium of the former species is characterized by the extraordinary depression of its fronto-parietal region, and by the very small width of the temporal fossæ. *S. ganesa*, on the other hand, is characterized by a development of

[1] Pal. Mem., Vol. II, p. 84.

the parieto-frontal region in much the same manner as in the living elephants, and by the consequently great width of the temporal fossæ.

Less typical skulls of *S. insignis,* as the specimen represented in fig. 1 of Plate XVII of the "Fauna Antiqua Sivalensis," and another in the Indian Museum, have a somewhat greater vertical development of the parieto-frontals. The temporal fossa in these skulls is, however, still very narrow. Young skulls of the species, however, have the fronto-parietal region well developed, as in *S. ganesa* (F. A. S., Plate XVIII, figs. 1, 2, 3), and it appears, therefore, that the aborted frontal region of *S. insignis* is only a characteristic of the adult.

That the one large cranium ascribed to *Stegodon ganesa* is not a single abnormality is proved by the existence of another very similar cranium, with the tusks broken off, obtained by Mr. Theobald in the Punjab, and now in the Indian Museum. This cranium was described by myself in the "Records,"[1] under the name of *S. ganesa.* The resemblance of this cranium to that named *S. ganesa* in the "Fauna Antiqua Sivalensis" is so close that I have thought it unnecessary to give a figure of it, almost the only difference between the two being that the former has the frontal region somewhat hollowed mesially in place of being quite flat as in the latter.

It thus appears that there are two very distinct forms of adult crania of *Stegodons,* which have the same dentition, and which in the young state also appear to be indistinguishable. On the whole, I now think it very probable that *S. ganesa* may be merely a very well marked race of *S. insignis,* or, in other words, may be a species in process of evolution. The adult race is, however, so well marked and so distinct that I prefer to continue to apply to it a separate specific name, with the above proviso.

On page 31 of the tenth volume of the "Records," I have noticed a specimen of a huge tusk of an elephant from the Narbada valley, which from its size and form seems to belong to *S. ganesa.* From the same deposits teeth which agree with those of *S. insignis* have been obtained, but no specimen of the cranium, and it is therefore not certain whether they might not also belong to *S. ganesa.* The discovery of the cranium of either of the *Stegodons* in the Narbada valley will be a matter of great interest, as we shall then see whether they had undergone any further differentiation in the period immediately succeeding that of the Siwaliks. I have already commented upon the similarity of certain of the molars of some of the Indian *Mastodons* as bearing upon the case of *S. insignis* and *S. ganesa,* in which no distinction can be found in the molars.[2]

[1] Rec. Geol. Surv. of India, Vol. IX, p. 42.

[2] It may be mentioned that the molars of two well defined species of Himalayan marmots (*Arctomys caudatus* and *A. himalayanus*) are absolutely indistinguishable, and if found in the fossil state would be referred to one species.

Sub-Genus 2: Loxodon, Falconer.

Elephants whose molars in most species have a higher ridge-formula than in the *Stegodons*, and in which the ridges are thinner and higher, and the valleys more completely filled with cement.

Species I: Loxodon planifrons, Falconer & Cautley.

General characters.—This species, together with the African elephant, in the characters of its molars, forms a link between the higher-ridged *Stegodons* and the extinct European *Loxodons*, the two species having a lower ridge-formula than any other species of the sub-genus *Loxodon*. We shall find that the number of ridges in the molars of this species are liable to a much greater degree of variation than is the case in any of the preceding species,—a variability correlated with the greater complexity of the molars of this group. Dr. Falconer[1] makes the ridge-formula of this species as follows:—

$$\frac{3+6+7}{3+6+7} - \frac{7+8+10}{7+(8-9)+(10-11)}$$

This formula does not give a sufficiently wide range of variation for the number of ridges, and another will be proposed after a short survey of the teeth.

The enamel ridges on the molars of this species are intermediate in height between those of *Stegodon insignis* and those of *Euelephas hysudricus;* when worn the crowns present lozenge-shaped cross-sections of the ridges, often with detached cylinders of enamel near the median line of the tooth; the enamel is of great relative thickness, and much crenulated or crimped in the higher portions of the ridges, but inferiorly this crimping is absent; this causes a great difference in the appearance of the crown-surface of a little-worn and a much-worn tooth. The molars of the species are readily distinguished from those of the *Stegodons* by the cement completely filling up the intervals between the enamel ridges. The present species is further distinguished from all other species of elephants, both recent and fossil, as far as is at present known, by having been furnished with two pairs of premolars in both upper and lower jaws,[2] in which respect it agrees with many species of *Mastodon.*

Cranium.—Figures of the cranium of *L. planifrons* will be found on Plates IX and X of the "Fauna Antiqua Sivalensis." The cranium is readily distinguished from that of any other species of elephant by the perfectly flat and expanded frontal region (whence the specific name), and by the small degree to which the temporal fossæ extend on to this surface. The nasal aperture is of relatively small

[1] Pal. Mem., Vol. II, p. 91.

[2] Fauna Antiqua Sivalensis, Pl. VI, figs. 4, 5, 6; Pl. XII, fig. 8.

extent, and the nasals themselves form a short protuberance. The pterygoids are small, and the incisive sheaths diverge to a considerable extent anteriorly.

Distribution.—Fossil remains of this species have been obtained only from the sub-Himalayan Siwaliks, and it appears that the geographical range of both this and the succeeding species did not extend into Sind, or into Perim Island, or Burma. A very large series of the molars of this species are contained in the collection of the Indian Museum, but as they do not differ from the beautiful series figured in the "Fauna Antiqua Sivalensis," none have been figured in this memoir.

First upper milk-molar.—A specimen of the first upper milk-molar is represented of the natural size in fig. 1 of Plate XII of the "Fauna Antiqua Sivalensis;" this tooth has three ridges and a talon.

First lower milk-molar.—Of the first lower milk-molar I cannot discover any specimen: Dr. Falconer gives the number of ridges in this tooth as three, probably from the number in the corresponding upper tooth.

Second upper milk-molar.—A detached specimen of a second upper milk-molar of this species in the Indian Museum (formerly in the collection of the Asiatic Society of Bengal, where it was catalogued by Dr. Falconer as belonging to *Stegodon insignis*), has six ridges and a talon: its length is 2·8 inches, and its greatest width 1·6 inches. Another specimen of this tooth, in a young cranium in the Indian Museum, seems to have only five ridges.

Second lower milk-molar.—There is no specimen of this tooth in the Indian Museum; the specimen represented in fig. 7 of Plate XII of the "Fauna Antiqua Sivalensis" has six ridges and a talon: its length is 2·4 inches, and its greatest width 1·4 inches.

Third upper milk-molar.—The number of ridges in the third upper milk-molar represented in fig. 4 of Plate VI of the "Fauna Antiqua Sivalensis" is six, with talons: the length of this tooth is 4·0 inches, and its greatest width 2·4 inches. A specimen in the Indian Museum has seven ridges.

Third lower milk-molar.—The specimen of the third lower milk-molar represented in fig. 8 of Plate XII of the "Fauna Antiqua Sivalensis," shows seven ridges, with talons: its length is 4·4 inches, and its greatest width 2·4 inches. Of two specimens in the Indian Museum, one shows eight ridges, and the other nine. The latter specimen was presented by the Roorkee Museum, and is but little worn; it exhibits well the characteristically thick enamel plates, widely separated, and enclosed in a large mass of cement.

First upper true molar.—The germ specimen of the first true molar in the young cranium represented in fig. 4 of Plate VI of the "Fauna Antiqua Sivalensis" exhibits seven ridges, and has a length of 5·5 inches with a width of 2·7 inches. I have not seen any other specimens of this tooth; it is, however, possible from the number of ridges in the last milk-molars, that the number of ridges in both upper and lower first true molars may sometimes be more than seven.

First lower true molar.—Of the first lower true molar, two specimens in the Indian Museum have seven ridges each: the length of one of these teeth is 6 inches, and its greatest width 2·8 inches. The specimen of the same tooth represented in fig. 10 of Plate XII of the "Fauna Antiqua Sivalensis" also shows the same number of ridges.

Second upper true molar.—In a very perfect palate specimen in the Indian Museum, showing the penultimate and last true molars, the penultimate tooth has eight ridges, with a length of 5·8 inches and a width of 4·2 inches: a smaller specimen in the same collection has nine ridges. The three specimens drawn in figs. 5, 5*a*, and 6 of Plate XII of the "Fauna Antiqua Sivalensis" have each eight ridges.

Second lower true molar.—Of two specimens of this tooth in the Indian Museum, one has eight, and the other nine ridges: the length of the latter tooth is 9 inches, with a width of 3·5 inches. The corresponding tooth represented in fig. 6 of Plate XI of the "Fauna Antiqua Sivalensis" carries nine ridges; the specimen represented in fig. 8 of the same plate has eleven ridges.

Third upper true molar.—The last molar in the large palate specimen referred to above has ten ridges, with a length of 11·5 inches and a width of 4·6 inches. The last true molar in the cranium figured in Plate X of the "Fauna Antiqua Sivalensis" has eleven ridges.

Third lower true molar.—A perfect specimen of this tooth in the Indian Museum has twelve ridges, with a length of 10·5 inches and a width of 4 inches. The same tooth in the lower jaw represented in fig. 2 of Plate XI of the "Fauna Antiqua Sivalensis" has thirteen ridges, while the specimen represented in fig. 12 of Plate XII of the same work exhibits only ten ridges.

Ridge-formula.—The foregoing survey of the molar series of *Loxodon planifrons* affords the following as the nearest approximation I can at present give to the ridge-formula of the species, *viz.*:—

$$\text{M. M.}\ \frac{3 \quad + (5-6) + (6-7)}{3\ (?) + \quad 6 \quad + (7-9)}\ \text{M.}\ \frac{7 + (8-9) + (10-11)}{7 + (8-11) + (10-13)}$$

Possibly some alteration will have to be made in the number of ridges in the first true molar, but otherwise the number of ridges are probably nearly correct. It will be observed that the "intermediate" molars are hepta-and octolophodont, and that the whole ridge-formula is very close to, though generally slightly higher than that of *Loxodon africanus*, as exhibited in the table given in the sequel. Both these species have a tendency to the prevalence of seven and eight ridges in the intermediate molars, and are doubtless links between the *Stegodons* and the higher-ridged *Loxodons*.

Sub-Genus 3: Euelephas, Falconer.

Elephants in which the ridges of the molars are developed into tall and nearly parallel plates, the intervals between which are completely filled with cement. The number of plates in the last lower molar may reach as many as twenty-four.

Species 1: Euelephas hysudricus, Falconer & Cautley.

General characters.—This species is the only representative of the thin-plated-toothed, or elasmodont, elephants found in the Siwaliks. The cranium and the dentition are well illustrated in the "Fauna Antiqua Sivalensis," and, therefore, I have not thought it necessary to figure the dentition in this memoir.

The cranium[1] is nearest in form to that of *Euelephas indicus*, but is readily distinguished by the alveoli of the tusks being straighter, as well as by the greater lateral development of the parieto-frontal protuberances, and by the greater incision of the temporal fossæ.

In describing briefly some of the specimens figured in the "Fauna Antiqua Sivalensis," Dr. Falconer remarks of the cranium—that the young tusks are oval in cross-section, that they diverge slightly, and are very near in size to those of the young Indian elephant, but are narrower in front and more convex. The palatal bones diverge in front and the infra-orbital foramen is of unusually large size. The ridge-formula of the molars is much lower than that of the Indian elephant, indicating that the fossil species forms a link connecting the latter with the loxodont elephants. The plates of enamel and ivory in the molars are lower than in other species of elasmodont elephants, but are narrow and vertical; the interspaces occupied by the cement are generally wider than the enamel and ivory plates themselves. The enamel is usually thicker than in the African elephant and much crenulated. The molars are at once distinguished from those of *Loxodon planifrons* by the plates being more numerous, narrower, and extending further down towards the root of the tooth, not being in fact mounted upon a common base of dentine as in that species. The enamel is also thinner, and the included ellipses on the worn crown surface much narrower. Specimens of the molars are not unfrequently found, from which the investing cement has decomposed and fallen off, leaving the enamel plates standing out separately in a manner which might lead the inexperienced observer to think that they belonged to a species distinct from that to which the complete teeth belonged. Great variability exists in the number of plates of the molars, there having not improbably existed two races, one with considerably more plates in the molars than the other.

A nearly complete specimen of the mandible is represented in fig. 7 of Plate XIII A of the "Fauna Antiqua Sivalensis;" it is characterized by a short symphysis, with a very small and narrow spout: a similar specimen is in the Indian Museum.

[1] F. A. S., Pl. XII B, fig. 4; Pl. XLIII, figs. 20 A and B.

Remains of this species have been found only in the sub-Himalayan Siwaliks to the eastward of the Jhelum river.

First milk-molars.—Of the first milk-molars, both upper and lower, I can find no specimens.

Second upper milk-molar.—In one young skull in the Indian Museum the second milk-molar has five ridges, and in another seven. The same tooth in the two skulls drawn in Plate VI, figs. 1 and 3, of the "Fauna Antiqua Sivalensis," has five ridges.

Second lower milk-molar.—The second lower milk-molars drawn in Plate VII, figs. 5 and 7 of the last-named work, have either seven or eight ridges, according as one is reckoned as a true ridge or a talon: a specimen doubtfully classed as the same tooth, drawn in fig. 6 of that plate, has nine ridges.

Third upper milk-molar.—In three young crania in the Indian Museum, the third milk-molar exhibits, respectively, eight, ten, and eleven ridges. The same tooth in the skull figured in plate VI, fig. 1, of the "Fauna Antiqua Sivalensis" has seven ridges, with fore-and-aft talons. Other specimens figured or referred to have the number of ridges between seven and nine.

Third lower milk-molar.—Two specimens of the third lower milk-molar drawn in figs. 8 and 9 of plate VII of the "Fauna Antiqua Sivalensis" have each nine ridges: a specimen of the same tooth in the Indian Museum (presented by the Roorkee Museum) has eleven ridges and two talons.

First upper true molar.—In a specimen of the cranium of *E. hysudricus* referred to in a note (No. 3) to the description of Plate VI of the "Fauna Antiqua Sivalensis" the number of ridges in the first true molar is given as eight; Dr. Falconer remarks that this tooth is remarkable for its unusual width, and the small number of ridges which it contains; a detached specimen of the same tooth figured in Plate VII, fig. 2, of the same work, has twelve ridges.

First lower true molar.—A specimen of the first lower molar in a jaw figured in Plate VIII, fig. 4, of the "Fauna Antiqua Sivalensis" has ten ridges, with a small hind-talon; another specimen drawn in fig. 10 of the preceding plate of the same work has twelve ridges.

Second upper true molar.—The second upper molar in the cranium drawn in Plate VIII, fig. 1, of the "Fauna Antiqua Sivalensis," has ten ridges and a large heel; the specimen of the same tooth drawn in fig. 3 of the preceding plate of the same work has twelve ridges.

Second lower true molar.—Two lower jaws in the Indian Museum, in which the second true molar is in wear, exhibit twelve and thirteen ridges, respectively, in that tooth.

Third upper true molar.—In two crania in the Indian Museum, in which the last true molar is in use, the tooth in one instance has thirteen ridges and talons, and in the other seventeen ridges.

Third lower true molar.—Three specimens of the last lower molar in the Indian Museum exhibit, respectively, fourteen, fifteen, and sixteen ridges. The specimen drawn in fig. 12 of Plate VII of the "Fauna Antiqua Sivalensis" shows seventeen or eighteen ridges.

Ridge-formula.—From the above series of teeth, the ridge-formula of the molars of *E. hysudricus* may approximately be represented as follows :—

$$\text{M. M.}\ \frac{?\ +\ (5-7)\ +\ (7-11)}{?\ +\ (7-9)\ +\ (9-11)}\ \text{M.}\ \frac{(8-12)\ +\ (10-12)\ +\ (13-17)}{(10-12)\ +\ (12-13)\ +\ (14-18)}$$

From the general symmetry of this formula, it is probable that it presents a very fair approximation to the truth. It will be found from the table of formula given below, that the position assigned to the species from this formula is between *E. mnaidriensis* and *E. antiquus*, or the second in the list of true elasmodont elephants: as being a pliocene species this ridge-formula, as being lower than that of the pleistocene species (with one exception, which will be referred to again below) is in accordance with the theory of evolution, and the less specialization of the older forms of a genus. The height of the ridges of the molars of this species is much less than in the Indian elephant: the height of the eighth ridge of the last upper molar of the former species averaging about 5½ inches, and in the latter upwards of 8 inches: the plates of the one are also much thicker than those of the other.

SPECIES 2: EUELEPHAS NAMADICUS, Falconer & Cautley.

The remains of this species of elephant have been obtained only from the Pleistocene deposits of the Narbada valley, there being no traces of its existence in the earlier Siwalik rocks. A considerable number of the true molars are figured in the "Fauna Antiqua Sivalensis," but, with the exception of the last lower milk-molar, no complete specimens of the milk-molars are there figured. The collection of the Indian Museum unfortunately contains no specimens of the milk-dentition, with the exception of the last lower milk-molar; so that the milk-molar dentition is virtually still unknown. A second upper true molar in the Indian Museum has twelve complete plates. The specimens in the latter collection, and those figured in the "Fauna Antiqua Sivalensis," enable me to make the following approximation to the ridge-formula of this species, *viz.* :—

$$\underset{\text{Milk-molars.}}{\frac{?\ +\ ?\ +\ ?}{?\ +\ ?\ +\ (9-10)}}\ —\ \underset{\text{True molars.}}{\frac{?\ +\ 12\ +\ 18}{(12-13)\ +\ (12-15)\ +\ (19-20)}}$$

This ridge-formula will be found to be extremely close to that of the dentition of the European *Elephas antiquus*, as given by Professor Leith Adams;[1] and from this resemblance of the ridge-formula, and from the great similarity of the teeth of the two species, that writer has come to the conclusion that the Narbada elephant is probably a variety of *E. antiquus*. With regard to this conclusion, in the first

[1] "Dentition and Osteology of Elephas antiquus," p. 47. Palæontograph. Soc., 1877.

place, as we have seen, the milk-molars of the Narbada species are, with one exception, unknown, and it is possible that their ridge-formula may differ somewhat from that of the milk-molars of *E. antiquus.* Secondly, there is the very peculiarly shaped cranium of *E. namadicus,* characterized by the great supraorbital ridge, well exhibited in the large cranium figured in plate XIIB of the "Fauna Antiqua Sivalensis," in another cranium in the British Museum, and in two crania in the Indian Museum. All the other crania of *E. namadicus* in the latter collection, and I believe also in the former, are imperfect superiorly, so that in all the complete crania known to me this very characteristic frontal ridge occurs, and it may, therefore, be fairly considered as characteristic of the Indian species. In noticing this peculiarity of the cranium of the Narbada elephant, Professor Leith Adams suggests[1] that it may be due to distortion, a view which, I think, is disproved by the facts given above.

Of *Elephas antiquus* Professor Leith Adams, in the above quoted passage, says, he is unacquainted with any English cranium, but refers to one in the museum at Rome, in which I infer, though it is not clearly expressed, that there is no ridge, like that of the Narbada elephant. If the cranium of the European elephant have no such ridge, while it is constant in the Indian form, I cannot think it by any means proved that *E. namadicus* and *E. antiquus* are varieties of one species, though there can be no doubt but that, as was admitted by Falconer, they are extremely closely allied, and possibly that the molars of the two are indistinguishable in a large series.

With regard to the great similarity of the teeth in the two species, we have already seen in the case of *Stegodon ganesa* and *S. insignis* that the teeth of two forms of elephant may be indistinguishable, while the crania are very widely different. In the lower true molars of *E. namadicus* there seems to be a tendency to a somewhat higher ridge-formula than in *E. antiquus.*[2]

As the crania and molars of *Elephas namadicus* in the collection of the Indian Museum do not differ from those figured in the "Fauna Antiqua Sivalensis," I have not considered it necessary to give figures of any of them on the present occasion.

The molars of this species are stated by Falconer to differ from those of *E. hysudricus,* in the greater height of the ridges or plates, in the slight amount of their thinning superiorly, and in their nearly vertical direction. There is also no loop near the middle of the plates on the grinding surface in the enamel, and the cement is thinner. The molars differ from those of *E. indicus* (apart from the difference in the number of ridges), by the worn dentine surfaces being thicker and presenting no curve towards the apex; the enamel is also thicker. In the crimping of the enamel plates the two species are very much alike.

[1] *loc. cit.,* p. 52.

[2] At page 68 of his memoir on *E. antiquus,* Prof. Adams seems to be under the impression that *E. namadicus* is found in the Siwaliks of Northern India and extends back into the Miocene. Remains of the species have only been found in the presumably Pleistocene deposits of the Narbada valley; *E. namadicus* is probably later in time than *E. antiquus,* and not earlier, as is stated by Prof. Adams.

TABLE SHOWING DIMENSIONS OF MOLARS OF INDIAN MASTODONS.

	Mastodon falconeri.		Mastodon pandionis.		Mastodon latidens.		Mastodon perimensis.		Mastodon sivalensis.	
	Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Upper.	Lower.	Upper.	Lower.
Length of first milk-molar	?	?	?	?	1·2	?	1·3	?	?	0·6
Width of ditto ditto	?	?	?	?	1·0	?	1·1	?	?	0·4
Length of second ditto	1·8	2·12	2·2	1·6	2·05	2·3	?	?	2·6	1·9
Width of ditto ditto	1·6	1·45	1·8	1·1	1·5	1·7	?	?	1·8	1·2
Length of third ditto	3·04	?	?	3·4	3·7	4·1	?	?	3·2	3·4
Width of ditto ditto	2·0	?	?	2·3	2·2	2·2	?	?	2·0	1·8
Length of first true molar	3·5	4·1	4·0	4·2	4·0	?	4·2	?	3·8	4·2
Width of ditto ditto	2·2	2·3	2·5	2·3	2·3	?	2·4	?	2·2	2·4
Length of second ditto	5·2	6·4	?	4·2	6·3	6·8	5·4	5·1	6·5	5·9
Width of ditto ditto	3·5	3·7	?	2·6	3·6	3·6	2·8	2·8	2·9	2·5
Length of third ditto	?	?	7·7	7·4	8·6	?	9·6	10·7	7·8	8·8
Width of ditto ditto	?	?	3·3	3·0	4·2	?	3·7	4·4	3·3	2·9
Length of penultimate premolar	0	0	?	?	1·6	?	?	?	0	0
Width of ditto ditto	0	0	?	?	1·4	?	?	?	0	0
Length of last ditto	0	0	2·05	?	2·2	?	2·4	?	0	0
Width of ditto ditto	0	0	1·5	?	1·8	?	1·7	?	0	0

TABLE SHOWING DIMENSIONS OF MOLARS OF STEGODONS.

	Stegodon cliftii.		Stegodon bombifrons.		Stegodon insignis and ganesa.	
	Upper.	Lower.	Upper.	Lower.	Upper.	Lower.
Length of first milk-molar	?	?	?	?	?	?
Width of ditto ditto	?	?	?	?	?	?
Length of second ditto	2·8	?	?	2·2	2·7	2·7
Width of ditto ditto	2·1	?	?	1·4	1·6	1·55
Length of third ditto	4·9	?	?	4·1	4·6	4·9
Width of ditto ditto	2·9	?	?	2·2	2·4	2·1
Length of first true molar	6·1	?	5·9	6·4	5·7	5·2
Width of ditto ditto	3·3	?	3·0	2·9	2·6	2·8
Length of second ditto	8·2	?	7·4	8·5	9·7	9·3
Width of ditto ditto	4·0	?	3·4	3·2	3·5	3·2
Length of third ditto	9·3	12·7	10·2	13·4	11·0	12·2
Width of ditto ditto	4·3	4·5	3·7	4·2	3·8	3·5

TABLE OF RECENT AND FOSSIL PROBOSCIDIA.[1]

Family I.—DINOTHERIDÆ.

GENUS: DINOTHERIUM (Kaup).

1. *D. giganteum* (Kaup.)	Europe.	Miocene.
2. *D. indicum* (Falconer)	India.	Mio-Pliocene.
3. *D. konigii* (Kaup.)	Europe.	Miocene.
? *D. bavaricum* (Meyer)		
? *D. cuvieri* (Kaup.)		
4. *D. pentapotamiæ* (Falc.)	India.	Mio-Pliocene.
5. *D. sindiense* (Lyd.)	India.	Miocene.

Family II.—ELEPHANTIDÆ.

GENUS I: MASTODON, (Cuvier).

TRILOPHODON	3. *M. andium* (Cuvier)	S. America.	Pliocene.
	4. *M. angustidens* (Cuvier)	Europe.	Miocene.
	M. simorrense (Lartet.)		
	M. cuvieri (Pomel.)		
	5. *M. borsoni* (Hays)	Europe.	Pliocene.
	M. buffonis (Pomel.)		
	6. *M. falconeri* (Lyd.)	India.	Mio-Pliocene.
	7. *M. humboltii* (Cuvier)	S. America.	Pleistocene.
	8. *M. maximus* (Cuvier)	N. America.	Pleistocene.
	M. ohioticus (Blum.)		
	M. giganteus (Auct.)		
	9. *M. obscurus* (Leidy.)	N. America.	Miocene(?).
	? *M. chapmani* (Hays)		
	10. *M. pandionis* (Falc.)	India.	Mio-Pliocene. Pleistocene(?)
	11. *M. pentelici* (Lart. & Gaud.)	Europe.	Miocene (?)
	12. *M. productus* (Cope)	N. America.	Pliocene.
	13. *M. pyrenaicus* (Lart.)	Europe.	Miocene.
	14. *M. tapiroides* (Cuvier)	Europe.	Miocene.
	M. turicensis (Schinz.)		
	15. *M. virgatidens* (Meyer)	Europe.	Miocene.
TETRALOPHODON	16. *M. arvernensis* (Croiz & Jobert)	Europe.	Upper Pliocene.
	M. brevirostre (Gervais).		
	17. *M. dissimilis* (Jourdan)[2]	Europe.	Upper Pliocene.
	18. *M. latidens* (Clift)	India.	Mio-Pliocene.
	19. *M. longirostris* (Kaup.)	Europe.	Miocene.
	20. *M. mirificus* (Leidy)	N. America.	Pliocene.
	21. *M. sivalensis* (Falc. & Caut.)	India.	Mio-Pliocene.
	22. *M. perimensis* (Falc. & Caut.)	India.	Mio-Pliocene.

[1] I believe this table to include all the species of which descriptions have reached India; there may be other species described lately which I have not seen. Only a few of the most important synonyms are given.—R. L.

[2] *M. dissimilis and M. longirostris* seem to have a tendency to the development of an extra ridge in the third and fourth molars.

Genus II: ELEPHAS (Linnè).

Sub-Genus 1: Stegodon (Falconer).

23. *S. bombifrons* (Falc. & Caut.) . . . India. Mio-Pliocene.
24. *S. cliftii* (Falc. & Caut.) . . . India and China. Mio-Pliocene.
    ? *S. sinensis* (Owen).
25. *S. ganesa* (Falc. & Caut.) . . . India. Mio-Pliocene and Pleistocene.
26. *S. insignis* (Falc. & Caut.) . . . India and China. Mio-Pliocene and (?) Pleistocene.
    ? *S. orientalis* (Owen).

Sub-Genus 2: Loxodon (Falconer).

27. *L. africanus* (Blum.) . . . Africa. Recent.
28. *L. melitensis* (Falc.) . . . Europe. Pleistocene.
    L. falconeri (Busk.)
29. *L. meridionalis* (Nesti.) . . . Europe. Pliocene.
30. *L. planifrons* (Falc. & Caut.) . . . India. Mio-Pliocene.

Sub-Genus 3:. Euelephas (Falconer).

31. *E. americanus* (DKay) . . . N. America. Pleistocene.
    E. columbi (Falc.)
32. *E. antiquus* (Falc.) . . . Europe. Pliocene.
    ? *E. intermedius* (Jourdan, MSS.)
    E. priscus (Gold.)
33. *E. armenaicus* (Falc.) . . . Europe. — ?
34. *E. hysudricus* (Falc. & Caut.) . . . India. Mio-Pliocene.
35. *E. indicus* (Linné.) . . . . India. Recent.
    E. sumatranus (Temminck.)
36. *E. mnaidriensis* (Adams.) . . . Europe. Pleistocene.
37. *E. namadicus* (Falc. & Caut.) . . . India. Pleistocene.
38. *E. primigenius* (Blum.) . . . Europe, Asia, and N. America. Pleistocene.

Table showing the number of ridges in the molars of the Proboscidia.

Genus: DINOTHERIUM.

	Milk-molars.	True molars.
All species	$\frac{1+2+3}{1+2+3}$	$\frac{3+2+2}{3+2+2}$

Genus: MASTODON.

Section A.—Trilophodon.

Normal species	$\frac{1+2+3}{1+2+3}$	$\frac{3+3+4}{3+3+(4-5)}$

SECTION B.—TETRALOPHODON.

	Milk-molars.	True molars.
Normal species	$\frac{2+3+4}{2+3+4}$	$\frac{4+4+5}{4+4+5}$
M. latidens	$\frac{2+3+4}{2+3+4}$	$\frac{(4-5)+(4-5)+(5-6)}{4+(4-5)+(5-?)}$
M. sivalensis	$\frac{2+3+4}{2+3+4}$	$\frac{4+(4-5)+(5-6)}{(?\,6)+(4-5)+(5-6)}$

GENUS: ELEPHAS.

SUB-GENUS 1: STEGODON.

S. cliftii	$\frac{?+4+6}{?+4\,(?)+6\,(?)}$	$\frac{6+6+(7-8)}{6?+6?+(7-8)}$
S. bombifrons	$\frac{?+4\,(?)+(5-6\,(?))}{?+4+(5-6)}$	$\frac{6+7+(8-9)}{7+7+9}$
S. insignis & *S. ganesa*	$\frac{2+5+7}{2+5+7}$	$\frac{(7-8)+(7-8)+(10-11)}{7+(7-12)+(11-13}$

SUB-GENUS 2: LOXODON.

L. africanus	$\frac{(2-3)+(5-6)+(4-7)}{(2-3)+(5-6)+(4-7)}$	$\frac{7+8+10}{7+(8-9)+(10-12)}$
L. planifrons	$\frac{3+(5-6)+(6-7)}{3\,(?)+6+(7-9)}$	$\frac{7+(8-9)+(10-11)}{7+(8-11)+(10-13)}$
L. meridionalis	$\frac{3+(5-6)+8}{3+6+8}$	$\frac{(8-9)+(8-10)+13}{8+(8-9)+(11-15)}$
L. melitensis	$\frac{3+5+8}{3+5+8}$	$\frac{8+9+12}{8+9+12}$

SUB-GENUS 3: EUELEPHAS.

E. mnaidriensis	$\frac{(2-3)+(4-6)+(8-9)}{(2-3)+(5-6)+(8-9)}$	$\frac{(8-9)+10+(12-13)}{(8-10)+10+(12-13)}$
E. hysudricus	$\frac{?+(5-7)+(7-11)}{?+(7-9)+(9-11)}$	$\frac{(8-12)+(10-12)+(13-17)}{(10-12)+(12-13)+(14-18)}$
E. antiquus	$\frac{(2-3)+(5-7)+(8-10)}{3+(6-8)+(9-11}$	$\frac{(9-12)+(12-13)+(15-20)}{(11-12)+(12-13)+(16-19)}$
E. namadicus	$\frac{?+?+?}{?+?+(9-10)}$	$\frac{?+12+18}{(12-13)+(12-15)+(19-20)}$
E. americanus	$\frac{4+8+12}{4+8+12}$	$\frac{12+16+20}{12+16+20}$
E. indicus	$\frac{4+(7-9)+(11-13)}{4+(7-8)+12}$	$\frac{(12-14)+(16-18)+24}{(12-14)+(16-18)+(24-27}$
E. armeniacus	$\frac{?+?+?}{?+?+?}$	$\frac{?+?+24}{?+?+?}$
E. primigenius	$\frac{?+(3-4)+(6-9)+(9-12)}{2+(3-4)+(6-9)+(9-12)}$	$\frac{(9-15)+(14-16)+(18-27)}{(9-15)+(14-16)+(18-27)}$

NOTE.—In the foregoing table the ridge-formulæ of the molars of the Indian fossil Proboscidia have been chiefly compiled from specimens in the Indian Museum, from those figured in the "Fauna Antiqua Sivalensis," and from Dr. Falconer's notes. In the other species the formulæ have been taken from the valuable memoirs of Professors Busk[1] and Adams[2] in the publications of the Zoological and Palæontographical Societies, and from the notes of Dr. Falconer. When, among the elephants with a high ridge-formula, a species appears (like *E. americanus*) with only a single cipher in each term, the formula must be regarded as only an approximation to the true one.

CONCLUSION.

At the close of this survey of the fossil Indian *Proboscidia*, a few general thoughts present themselves, which we will now consider.

We find that in the Siwalik period there lived in India three species of *Dinotherium*, five of *Mastodon*, four of *Stegodon*, one of *Loxodon*, and one of *Euelephas*. In the succeeding Narbada period, this proboscidian fauna, which is the richest in the world, was greatly reduced in number, and was only represented by possibly two species of *Stegodon* and one of *Euelephas*, the two former being Siwalik species and the latter new. It is, however, possible that *Mastodon pandionis* may have lived in the same period, as its teeth are said to have been found in the Deccan. In modern India this fauna has dwindled down to one species of *Euelephas*,—a species which is not known before the period of the recent alluvium.

We find that the whole of these species of *Proboscidia* (unless we accept Professor Leith Adams' identification of *E. namadicus* with *E. antiquus*) are peculiar to India, but that many of them are represented by allied species in the Tertiaries and Post-Tertiaries of Europe.

The following table exhibits this relationship:—

INDIAN.	EUROPEAN.
Dinotherium, 3 sp. Mio-Pliocene.	No very closely allied species. Genus of upper Miocene age.
Mastodon pandionis Mio-Pliocene, Pleistocene (?).	*M. angustidens.* Upper Miocene.
M. falconeri Mio-Pliocene.	No closely allied form, though approaching last species in form of molars.
M. latidens Mio-Pliocene.	No allied species.
M. perimensis Mio-Pliocene.	*M. dissimilis*[3]. Upper Pliocene. *M. longirostris.* Upper Miocene.

[1] Trans. Zool. Soc., London, Vol. VI.

[2] "British Fossil Elephants" Pal. Soc., 1877-79. "Maltese Fossil Elephants": Trans. Zool. Soc., London, Vol. IX.

[3] Of *M. dissimilis* I have only seen the figures of the molars given in Vol. II of the "Archives du Museum D'Histoire Naturelle de Lyon:" the letter-press having not yet reached India. The molars seem to be of the type of *M. longirostris*, but have less distinct trefoils.

Indian.	European.
M. sivalensis	*M. arvernensis.*
Mio-Pliocene.	Upper Pliocene.
Stegodon	No European representative of the sub-genus.
Mio-Pliocene and Pleistocene.	
Loxodon planifrons	No closely allied European species.
Mio-Pliocene.	Sub-genus Pliocene to Recent.
Euelephas hysudricus . . .	No closely allied European species.
Mio-Pliocene.	Sub-genus Pliocene to Recent.
Euelephas namadicus	*Euelephas antiquus.*
Pleistocene.	Pliocene.
Euelephas indicus	*Euelephas primigenius.*
Recent.	Pleistocene.

With regard to the age of the Siwaliks as indicated by the Proboscidia, we find that these deposits contain the genus *Dinotherium*, which is characteristic of the upper Miocene of Europe. Of the *Mastodons* we find a mingling of Miocene and Pliocene forms in the Siwaliks. *Stegodon* is unknown in Europe, while *Loxodon* and *Euelephas* do not occur before the Pliocene in Europe.

Another fact, however, presents itself. It will be found from the distribution given in the text, that the whole of the species and genera of Indian Proboscidia which are represented by allied species in the Miocene of Europe (with the possible exception of *M. pandionis*) are found only in the Siwaliks of Sind, the Western Punjab, and Perim Island. On the other hand, the species which are represented by allied species in the post-Miocene of Europe are mainly found only to the east of the Punjab; the only exception being *M. sivalensis*, which is also found somewhat to the west of the Jhelum, but not in Sind.

These facts therefore, as far as the evidence of one group of fossils goes, would show that the whole mammaliferous beds of Northern India range from the upper Miocene well into the Pliocene period, and that the strata on the east of the Jhelum are mainly of Pliocene age, while those to the west of that river are partly, at all events, of Miocene age.

These conclusions precisely agree with those which I have arrived at elsewhere, from other evidence, as to the age of the Siwaliks, and there is, therefore, a strong presumption of their correctness.[1]

[1] The view that the Siwaliks are in great part of Pliocene age seems to be gradually gaining ground among palæontologists. In a lecture on the "Extinct Mammals of North America," delivered by Professor Flower, before the Royal Institution, on March 10th, 1876, the author speaks of the Siwaliks as belonging to a transitional period between the Miocene and Pliocene (p. 12). Professor Rütimeyer in his memoir on "Die Rinder der Tertiär-Epoche" (Abhand. der Schweiz Pal. Gesell., Vol. V, 1878, pp. 184—89,) adopts a similar view. Professor O. C. Marsh in his paper on the "History and Methods of Palæontological Discovery" (Amer. Journ. of Sci. and Arts, p. 348, November 1879), refers to the Siwaliks as being of Pliocene age.

Professor Le Conte, however, in his recently published "Elements of Geology," p. 498 (New York, 1879), totally ignores the partially Pliocene age of the Siwaliks, and classes them altogether as Miocene. He also ignores the numerous additions to the mammalian fauna of those rocks made by myself, and noticed in the previous parts of this volume, and in the "Records" of the last few years. In the last edition of Professor Nicholson's "Palæontology"

In the list of Proboscidia given above, out of a total of thirty-eight species, no less than sixteen, or nearly one-half, belong to India, and fourteen of these to the Siwalik period. There is no better instance than the Proboscidia of the enormous richness of the Siwalik fauna in large forms, and of their almost total extinction at the present day. The cause of this extinction has been attributed to the glacial period by Professor Huxley,[1] who was followed by Mr. Wallace.[2]

In the table of ridge-formulæ of the sub-genus *Euelephas* given above, one very noticeable point presents itself, which I will shortly refer to. It will be observed that, with the remarkable exception of *E. mnaidriensis*, the arrangement of the species from their ridge-formulæ, corresponds very closely with the order of their appearance in time, the two Pliocene species coming first, and then the Pleistocene and Recent species. *Euelephas mnaidriensis* occurs somewhat out of its position in time, in the ridge-arrangement: this, however, must probably be regarded as a special instance of an earlier development of the higher type.

Again, *E. primigenius* attained a higher development of its ridge-formula than its successor in time, the Indian elephant.

With regard to the last-named species, it may be well to notice that Professor Boyd Dawkins[3] has recently expressed his opinion that *E. primigenius* is the parent of *E. indicus*, and that the latter is specifically identical with *E. americanus* (*columbi*) and *E. armeniacus*. I have not myself had an opportunity of examining a large series of the molars of these species, and the following remarks are, therefore, submitted with deference. In the first place, it seems to me somewhat improbable that the whole of the fossil Indian elephants were entirely swept away and replaced by a western form, which *E. indicus* must be according to Professor Dawkins, this replacement having probably taken place within the human period, as we have no evidence of the existence of the last-named species previous to that period in India. Further, according to Dr. Falconer, the molars of *E. primigenius* are broader, and have thinner and more numerous plates than those of *E. indicus*, showing that the supposed descent would be retrogressive instead of progressive. Dr. Falconer [4] even goes so far as to place the two forms in distinct groups, *E. primigenius* belonging to his eurycoronine and *E. indicus* to his stenocoronine group. Again, the highly curved tusks of the mammoth are strangely unlike those of the Indian elephant.[5] I cannot at present indicate the line of descent of the latter species from any of the fossil Indian forms, but it may be observed that both the Narbada *E. namadicus* and the Siwalik

(1879), the Siwaliks are generally classed as upper Miocene, and none of the mammals discovered since Falconer's time are noticed.

[1] Presidential Address to Geological Society of London, 1870, P. G. S. L., p. lvii, 1870.

[2] "Geographical Distribution of Animals," Vol. I, p. 150. In the "Manual of the Geology of India" (p. 587), Mr. W. T. Blanford attributes the origin of the theory of the extinction of the great mammals by the glacial period to Mr. Wallace, whereas it seems to have been first put forth by Professor Huxley in the passage quoted above.

[3] Quar. Jour. Geol. Soc., London, 1879. p. 145.

[4] Pal. Mem., Vol. II, p. 13.

[5] I am informed by Mr. A. O. Hume that a pair of tusks of the Indian elephant in the possession of one of the native princes are curved like those of the mammoth.

E. hysudricus have simpler molars than those of the Indian elephant, and that any descent from these forms would be in the order of regular progressive development. With regard to the first named species, I do not think that the Indian elephant could be descended from it, because the Narbada elephant lived to a very recent date in India, and because of its very peculiarly shaped skull. *E. hysudricus*, on the other hand, lived at an earlier period, and has a skull which only requires a little modification to bring it to that of the Indian elephant. It must also be remembered that in Northern India, where all the Siwalik elephants lived, we have (with one or two possible exceptions) no record of the animals which lived subsequently to the Siwalik (Pliocene) period, and we have therefore no means of saying whether *E. hysudricus* then became extinct, or whether it lived on and became developed into a more specialized form. I do not put forward these suggestions as having any certainty, but merely as points for consideration before the two species can be classed together. I may add that in the discussion which followed the reading of Professor Dawkins' paper, Professor L. Adams expressed his opinion that *E. primigenius* and *E. indicus* were decidedly distinct, but that *E. americanus* (*columbi*), *E. armeniacus*, and *E. indicus* might possibly be the same species.

The growing tendency which there appears to be among mammalian palæontologists to take little heed of more or less minute points of difference, and to unite distinguishable forms under one species, appears to me to be a retrograde movement, which is especially confusing to the geologist, as it deprives him of all assistance in identifying strata by their included remains. The identity of the Indian elephant and the mammoth is no new idea, but was originally adopted by De Blainville,[1] who said that he could not distinguish between the two. The elaborate labours of Falconer subsequently showed the points which distinguish the mammoth from other allied elephants, labours which seem in a fair way of being disregarded by modern writers.

References to non-Indian species of fossil Proboscidia.[2]

Dinotherium giganteum.

Kaup: "Ossements Fossiles des Mammiferes qui se trouvent au Museum grand-ducal de Darmstadt," Darmstadt, 1832.

Dinotherium konigii.

Kaup: Art. 15, pp. 5—14.

Meyer: Jahrbuch, 1831, p. 296, 1836, p. 59.

(*D. bavaricum*).

Mastodon andium.

"Hugh Falconer, Palæontological Memoirs of the late," by C. Murchison, London, 1868, Vol. I, p. 99, II, p. 14.

[1] "Osteographie" des Elephants, p. 222.

[2] This list of references is not meant to make the least approach to a complete bibliography of the fossil Proboscidia, but is merely intended to enable the reader to make comparisons between the Indian species figured in this volume with the non-Indian species.

M. angustidens.
M. Vacek: "Abhand. der k. k. Reichs.," Wien, Vol. VII, pt. 4, 1877. Biederman: "Abhand. der Schweiz pal. Gesell.," Vol. III, 1876.
Falconer: "Pal. Mem.," Vol. I, p. 89, II, pp. 14, 21.
E. Sismonda: "Osteographia di un Mastodonte angustidente." Mem. Acc. real. di Torino, Ser. II, Vol. XII, 1852.
Meyer: "Palæontographica," Vol. XVII, Cassel. Lortet and Chantre, Archiv. du Mus. d'Hist. Nat. de Lyon, Vol. II. Lyons, 1878.

M. borsoni.
M. Vacek: loc. cit.
Lortet and Chantre: loc. cit.

M. humboltii.
Meyer: loc. cit.
Lortet and Chantre: loc. cit.

M. maximus.
Warren: "Descrip. of skeleton of M. giganteus (maximus)." Boston, 1852.
Lortet and Chantre: loc. cit. (*M. ohiotieus.*) Leidy: "Contributions to Extinct Vertebrate Fauna of the Western Territories." Washington, 1873, Vol. I, p. 237. (*M. americanus*).

M. obscurus.
Leidy: "Contributions to Extinct Vertebrate Fauna of the Western Territories." Washington, 1873, Vol. I, Pl. XXI, p. 231.

M. pentelici.
Gaudry: "Animaux Fossiles et Géologie de l'Attique." Paris, 1862.

M. productus.
Cope: "U. S. Geograph. Survey, W. of 100th Meridian," Vol. IV, Pt. II, p. 306, Pls. LXX—LXXI. Philadelphia, 1877.

M. pyrenaicus, Lartet, MSS.

M. tapiroides.
Gaudry: "Animaux Fossiles et Géologie de l'Attique." Paris, 1862. (*M. turicensis*).
M. Vacek: loc. cit.
Meyer: loc. cit. (*M. turicensis*).
Lortet and Chantre: loc. cit.

M. virgatidens.
Meyer: loc. cit.

M. arvernensis.
Croizet et Jobert, "Recherches sur less Ossemens Fossiles du departement du Puy-du-dome," Paris, 1828.
M. Vacek: loc. cit.
Falconer: Pal. Mem., Vol. II, pp. 14, 26, 39.

M. dissimilis.
Lortet and Chantre: loc. cit.

M. longirostris.
Kaup: loc. cit.
M. Vacek: loc. cit.
Lortet and Chantre: loc. cit.
Falconer: Pal. Mem., Vol. I, pp. 159, 107, 468, 472, II, pp. 14, 23.

M. mirificus.
Leidy: loc. cit., p. 237.
—— "Extinct Mammalian Fauna of Dakota and Nebraska." Jour. Acad. Nat. Sci. Philadelphia, Ser. II, Vol. VIII, p. 249, Pl. XXV, figs. 1, 2. Philadelphia, 1869.

Loxodon melitensis.
L. Adams: "Maltese Fossil Elephants," Trans. Zool. Soc., London, Vol. IX.
Busk: Trans. Zool. Soc., London, Vol. VI.

L. meridionalis.

Ducrot and Lortet: Archiv. du Mus. d'Hist. Nat. de Lyon, Vol. I, 1876.

Falconer: loc. cit., Vol. II, p. 118.

Euelephas americanus.

Leidy: "Extinct Mammalian Fauna of Dakota and Nebraska," p. 251.

Falconer: Pal. Mem., Vol. II, pp. 14, 211, 212.

E. antiquus.

Ducrot and Lortet: loc. cit.

L. Adams: "Dentition and Osteology of *E. antiquus*," Palæontographical Society, 1877.

Boyd-Dawkins: Quar. Jour. Geol. Soc., London, Vol. XXVIII, p. 413.

Falconer: Pal. Mem., Vol. II, pp. 14, 147.

E. mnaidriensis.

L. Adams.

"Maltese Fossil Elephants," Trans. Zool. Soc., London, Vol. IX.

Busk: Trans. Zool. Soc., London, Vol. VI, p. 251 (*E. falconeri*).

E. primigenius.

Ducrot and Lortet: loc. cit.

Falconer: Pal. Mem., Vol. I, pp. 79, 421, II, pp. 14, 158.

Boyd-Dawkins: Quarterly Journal of the Geological Society of London, Vol. XXXV, p. 138.

L. Adams: "Dentition and Osteology of *Elephas primigenius*." Palæontographical Society, 1879.[1]

[1] Only just received in India; the presumed occurrence of the pre-antipenultimate milk-molar in the mammoth, would have been noticed in the note on the dentition of the Elephants, if Prof. Adams' memoir had arrived in time. B.L. March 1880.

APPENDIX.

Since the above was in type, several specimens of Siwalik proboscidian remains have been received in the Indian Museum, some of which require a short notice, and have engendered the necessity of issuing an additional plate (XXXV A).

Dinotherium sindiense, nobis.

Of this species, a single ramus of the mandible, collected by Mr. Wynne in the Siwaliks of the Kohát District, has been received by the Indian Museum. The crowns of the molars in this jaw have, unfortunately, all been broken off, but the size and form of the jaw agree precisely with those of the Sind specimen (Plate XXXI, fig. 4), and confirm the conclusions deduced therefrom.

Mastodon pandionis, Falconer.

Mr. Theobald has remitted to the Indian Museum a magnificent specimen of the palate of this species, from Níla in the Punjab, showing the penultimate and last true molars of either side. In Plate XXXV A, the two teeth of the left side have been figured. These two teeth are very important, as completing our knowledge of the true molar dentition of this species; no specimen of the penultimate upper molar was known to me when describing the dentition in detail, and only one bad specimen of the last molar, alluded to on page 218. I shall not describe the new teeth in detail, but merely mention their leading features.

The penultimate tooth is considerably worn, carries three transverse ridges, and may have had a small hind-talon. The last molar is only slightly worn, and carries four ridges and an anterior talon: the ridges of this tooth diminish in size gradually from the first to the last. A large quantity of cement is present in the valleys, which are completely blocked by accessory columns or tubercles. The ridges when worn present irregularly shaped, and depressed surfaces of dentine.

In all the above characters, these two teeth agree with the molars of *M. pandionis* described above, and unquestionably belong to that species: they show that the species was a true *Trilophodon.*

In the palate, the two teeth of either side converge to a very small extent anteriorly: their plane of wear slopes very considerably from the outer to the inner side. The dimensions of the specimen are as follows :—

	In.
Length of two molar teeth	11·3
Interval between outer sides of last molar at second ridge	10·5
Interval between inner sides of ditto at same point	3·0
Interval between antero-internal angles of penultimate molars	2·8
Length of penultimate molar	5·1
Width of ditto ditto	3·6
Length of last ditto	6·2
Width of ditto ditto	3·9

This specimen shows that in its last upper molar, *M. pandionis* makes no approach to *M. sivalensis* (Plate XLIV, fig. 1), and in this respect differs from the lower molars, as I have noticed above (page 226).

The penultimate molar of the new specimen is very important, as showing the difference of this tooth from the corresponding molar of *M. falconeri* (Plate XXXII, fig. 1). The two teeth are in different conditions of wear, that of *M. falconeri* being the least worn, but they still permit of comparison. It will be observed that the molar of *M. pandionis* presents irregular, and not trefoil-shaped surfaces of dentine on its inner columns, and that its valleys are completely blocked. If the molar of *M. falconeri* were worn as much as that of *M. pandionis*, the dentine surfaces of the two first ridges, as well as those of the two columns in each ridge, would have been united, instead of remaining quite distinct: this is shown in the first upper true molar of *M. falconeri*, drawn in fig. 4 of Plate XXXII. Again, the molar of *M. pandionis* must have had only a very small hind-talon, as the width of the united hind-ridge and talon is very little in excess of the second ridge: in *M. falconeri*, on the other hand, the width of the united hind-ridge and talon is equal to the width of the second ridge, *plus* half that of the first. Finally, the two teeth are broadly distinguished by the presence of cement in the one and its complete absence in the other.

Mr. Theobald has also sent there detached specimens of the last upper true molar of *M. pandionis*, two of which agree with the figured specimen, while the third has a hind-talon, like the specimen referred to on page 218.

Since the whole of the plates illustrating this memoir have been lithographed, a comparison of the figures of the last lower molars of *M. pandionis* and *M. sivalensis* has shown me that I had overlooked certain differences between them. The right last lower molar of the former species drawn in fig. 4 of Plate XXXV will be seen to be convex externally and straight internally, the reverse being the case with the corresponding tooth of *M. sivalensis* drawn in fig. 3 of Plate XLIV; the latter tooth is also narrower than the former. The corresponding tooth of *M. pandionis* drawn in fig. 2 of Plate XXXIV, which succeeds an undoubted trilophodont tooth, appears in the engraving to be slightly concave on the outer side; this is, however, an error on the part of the native artist; the outer border of the base of the crown is in reality perfectly straight, a rod laid along the base of the outer columns touching them all, whereas in *M. sivalensis* a similarly placed rod would only touch the two end columns. The last lower molar of *M. pandionis* has, therefore, its external surface either convex or straight, and in the former case, its hinder extremity inclines towards the inner side. In *M. sivalensis*, on the other hand, the last lower molar (as is shown in my figure and in the specimen with more ridges drawn in fig. 8 of Plate XXXVII of the "Fauna Antiqua Sivalensis") has its outer surface always concave, and its hinder extremity inclining towards the outer side. The specimen represented in fig. 2 of Plate XXXIV approaches in form to the tooth of *M. sivalensis*, but is widely distinguished by the presence of a large quantity of cement. Another specimen of the last lower molar of *M. pandionis* in the Indian Museum, is intermediate in character between the two figured specimens. We thus see that in this species there is a form with narrow, and another with broad molar teeth.

Mastodon pyrenaicus, Lartet.

On page 212 I stated that I could not find any description of the molars of this species. I have subsequently come across a figure of the last upper molar given by M. Gaudry.[1] It seems that that writer is inclined to consider *M. pyrenaicus* merely as a variety of *M. angustidens*.

[1] "Les Enchainements du Monde Animal," page 174.

MASTODON DISSIMILIS, Jourdan.

The text of MM. Lortet and Chantre's monograph on the Mastodons of the Rhine basin, alluded to on pages 286 and 290, has just been received in India: from this memoir I find that *M. dissimilis* is merely a synonym of *M. arvernensis,* and not a distinct species. The name *dissimilis* is a manuscript one proposed by the late M. Jourdan in 1840 for specimens in the Lyons museum. The name of *M. arvernensis* was applied by Croizet and Jobert in 1826, and has always been recognized by subsequent writers. I cannot but think it extremely ill-advised to rake up an utterly forgotten name for a well known species, and still more so to publish the plates under that name without the explanatory text.

March 1880.

INDEX.

N. B.—The numbering of the pages in this Index refers to the volume paging, and not to the separate paging of each part. Synonyms are in *italics*.

INDEX

TO THE

PLATES OF MOLAR TEETH AND OTHER REMAINS OF MAMMALIA

FROM THE

TERTIARY BEDS

OF

INDIA AND BURMA.

EXPLANATION OF PLATES

TO

RHINOCEROS DECCANENSIS.

PLATE I.

1.—View of masticatory surface of the upper molar series, left side.
2.—Left upper molars from the inner side.

PLATE II.

1.—Third and fourth upper premolars, left side, view of outer wall.*
2.—Fragment of first true molar, right side, showing the inner wall of anterior valley (*a*), to illustrate its great depth.
3.—Outer side of left ramus of mandible. Half natural size.†
4.—Symphysis of mandible seen from above.

PLATE III.

1.—Squamosal bone with meatus auditorius (*a*), post-glenoid process (*b*), and post-tympanic process (*c*) ;—(*d*) parts of supra-occipital and ex-occipital (?) bones.
2.—Outer sides of left lower molars.
3.—Crown view of ditto ditto.

All the letters not given here will be found given at page 8.

* This view represents the teeth in their normal position, and does not therefore show their full height.

† The hindermost molar should be marked m_3 instead of m_1.

[Reprint.]

PLATE I.

Rhinoceros deccanensis, Foote.

Fig. 1. View of masticatory surface of the upper molar series, left side.

Fig. 2. Left upper molars, from the inner side.

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[Reprint.]

PLATE II.

RHINOCEROS DECCANENSIS, Foote.

Fig. 1. Third and fourth upper premolars, left side, view of outer wall.[1]

Fig. 2. Fragment of first true molar, right side, showing the inner wall of anterior valley (*a*), to illustrate its great depth.

Fig. 3. Outer side of left ramus of mandible. Half natural size.[2]

Fig. 4. Symphysis of mandible seen from above.

[1] This view represents the teeth in their normal position, and does not therefore show their full height.

[2] The hindermost molar should be marked m^3 instead of m^1.

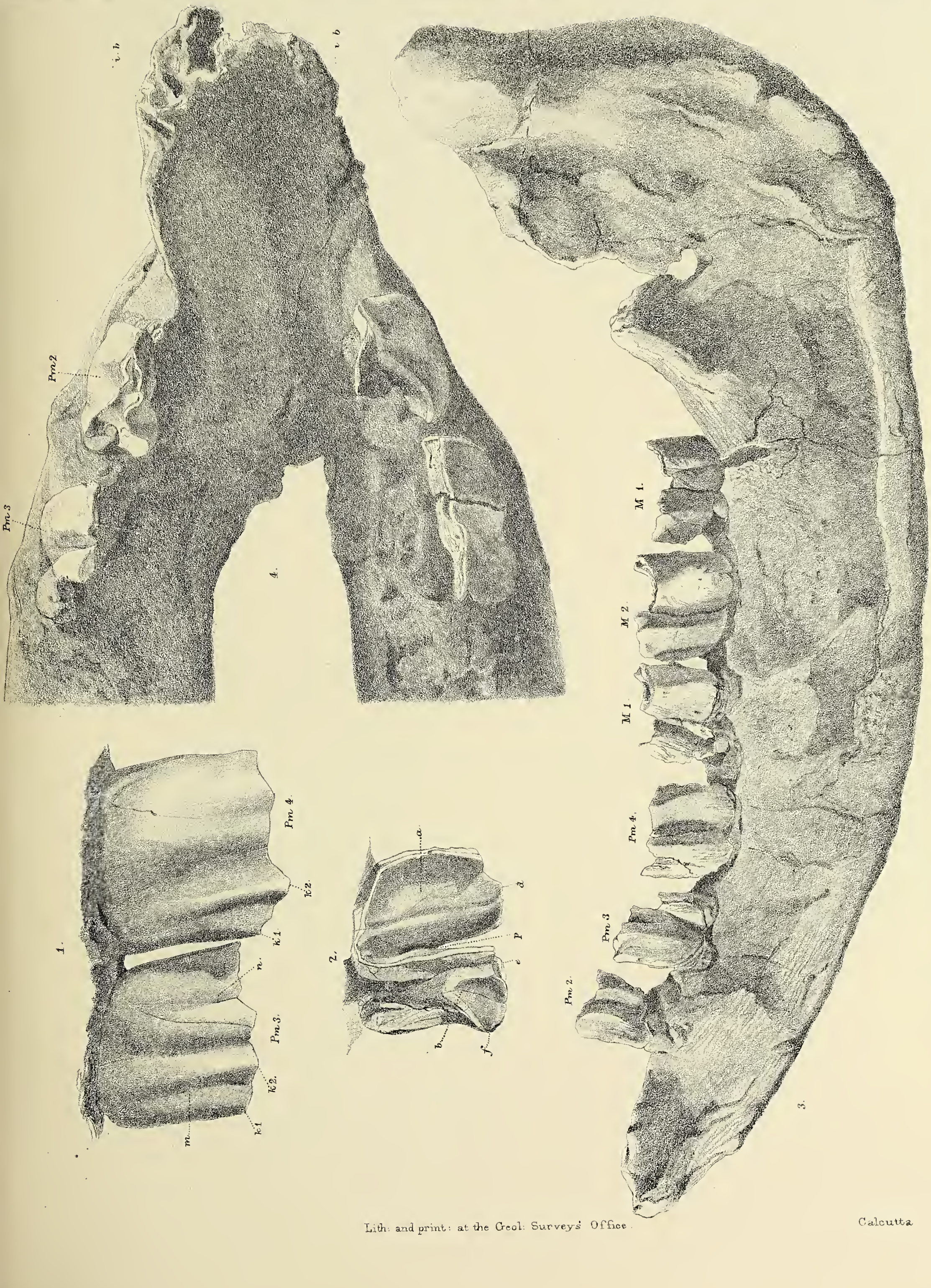

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PLATE III.

Rhinoceros deccanensis, Foote.

Fig. 1. Squamosal bone with meatus auditorius (*a*), post-glenoid process (*b*), and post-tympanic process (*c*) : (*d*) parts of supra-occipital and ex-occipital (?) bones.

Fig. 2. Outer sides of left lower molars.

Fig. 3. Crown view of ditto.

All the letters not given here and in preceding plates will be found given on page 8.

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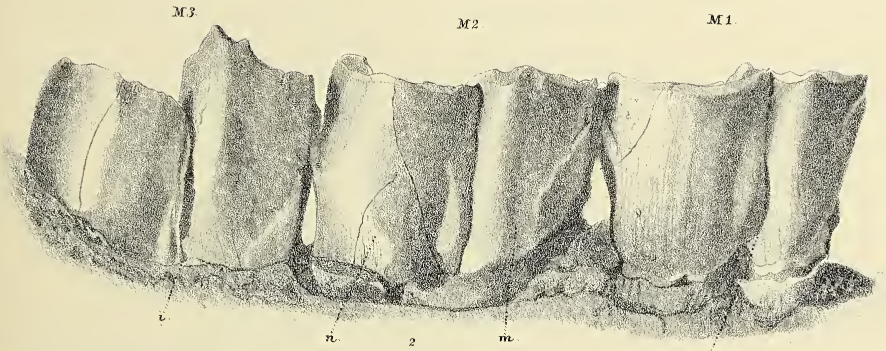

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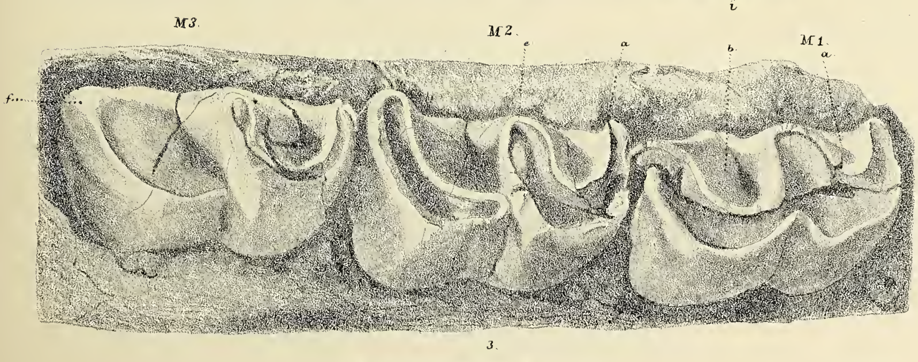

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PLATE IV.

RHINOCEROS & ACEROTHERIUM.

Fig. 1. RHINOCEROS PALÆINDICUS, Falc. & Caut.: fragment of upper molar of the left side: Siwalik.

Fig. 2. RHINOCEROS SIVALENSIS, Falc. & Caut.: 3rd upper true molar of the right side: Siwalik.

Fig. 3. RHINOCEROS PALÆINDICUS, Falc. & Caut.: upper premolar of the right side: Siwalik (copied from "F. A. S.," Plate LXXIV, fig. 4).

Fig. 4. RHINOCEROS PLATYRHINUS, Falc. & Caut.: 2nd upper true molar of the right side (copied from "F. A. S.," Plate LXXV, fig. 11*a*).

Fig. 5. RHINOCEROS INDICUS, Cuv.: 3rd upper true molar of the left side: Narbada valley; described in second fasciculus as R. NAMADICUS.

Fig. 6. RHINOCEROS INDICUS, Cuv.: 2nd upper true molar of the right side: Narbada valley; described in second fasciculus as R. NAMADICUS.

Fig. 7. ACEROTHERIUM PERIMENSE, Falc. & Caut.: upper true molar of the right side: Siwalik; described in text as RHINOCEROS PLANIDENS, *nobis*.

Fig. 8. RHINOCEROS SIVALENSIS, Falc. & Caut.: 2nd upper true molar of the right side: Siwalik (copied from Messrs. Baker and Durand's memoir).

Fig. 9. ACEROTHERIUM PERIMENSE, Falc. & Caut.: upper molar of the left side: Siwalik; described in text as RHINOCEROS PLANIDENS, *nobis*.

Figs. 3 and 4 one-half natural size; fig. 8 one-quarter natural size; the rest natural size.

PLATE IV.—RHINOCEROS.

Fig. ... 1. Rhinoceros palæindicus, *Falc. and Caut.:* upper molar; left side. Lehri—Siwaliks. No. 57.

Fig. ... 2. Rhinoceros sivalensis, *Falc. and Caut.:* 3rd upper molar; right side. Katana—Siwaliks. No. $\frac{S.}{105}$.

Fig. ... 3. Rhinoceros palæindicus, *Falc. and Caut.:* upper premolar; right. Siwaliks (copied from "F. A. S." plate 74, fig. 4).

Fig. ... 4. Rhinoceros platyrhinus, *Falc. and Caut.:* 2nd upper molar; right side (copied from "F. A. S." plate 75, fig. 11*a*).

Fig. ... 5. Rhinoceros namadicus, *Falc. et nobis:* 3rd upper molar; left side. Narbudda Valley. No. 471.

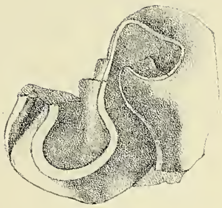
Fig. ... 6. Rhinoceros namadicus, *Falc. et nobis:* 2nd upper molar; right side. Narbudda Valley. No. 470.

Fig. ... 7. Rhinoceros planidens, *n. sp. nobis:* upper molar; right side. Gadarí—Siwaliks. No. 56.

Fig. ... 8. Rhinoceros sivalensis, *Falc. and Caut.:* 2nd upper molar; right side. Siwaliks (copied from Messrs. Baker and Durand).

Fig. ... 9. Rhinoceros planidens, *n. sp. nobis:* upper molar; left side. Gadarí—Siwaliks. No. $\frac{N}{7}$.

Figures 3 and 4 one-half natural size; figure 8 one-quarter natural size; the rest natural size.



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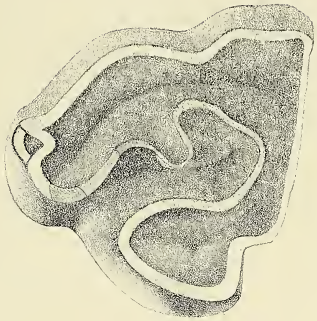

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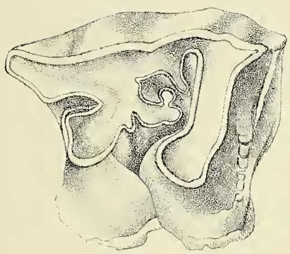

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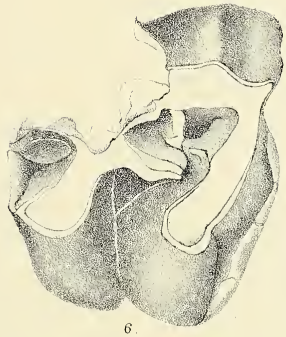

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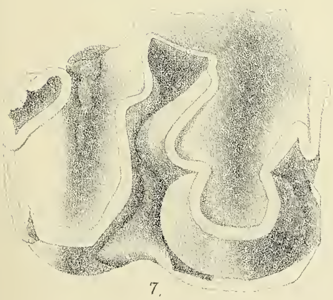

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PLATE V.—RHINOCEROS.

Fig. ... 1. Rhinoceros iravadicus, *n. sp. nobis:* 2nd upper molar; left side: specimen found in a Pagoda at Prome and presented to the Indian Museum by Col. Phayre. No. 219.

Fig. ... 2. Rhinoceros iravadicus, *n. sp. nobis:* 2nd upper molar; right side. Irawadí Valley. No. 216.

Fig. ... 3. Rhinoceros iravadicus, *n. sp. nobis:* portion of occiput. Pegu. No. 251.

Fig. ... 4. Rhinoceros sivalensis, *Falc. and Caut.:* 2nd upper molar; left side. Asnot—Siwaliks. No. 780.

Fig. ... 5. Rhinoceros, *n. sp. ?* upper premolars; right side. Burma. No. 220.

Figure 3 one-third natural size; the rest natural size.

[Reprint.]

PLATE V.

Fig. 1. Rhinoceros iravadicus, *n. sp. nobis:* 2nd upper true molar of the left side: specimen found in a pagoda at Prome, and presented to the Indian Museum by Sir A. Phayre.

Fig. 2. Rhinoceros iravadicus, *n. sp. nobis:* 2nd upper true molar of the right side: Irawadi valley.

Fig. 3. Rhinoceros iravadicus, *n. sp. nobis:* portion of occiput: Pegu.

Fig. 4. Rhinoceros iravadicus (?) *n. sp. nobis:* two upper milk-molars of the right side: Burma: described in text as being the premolars of a possibly new species.

Fig. 5. Rhinoceros sivalensis, Falc. & Caut.: 2nd upper true molar of the left side: Siwalik.

Fig. 3 one-third natural size; the rest natural size.

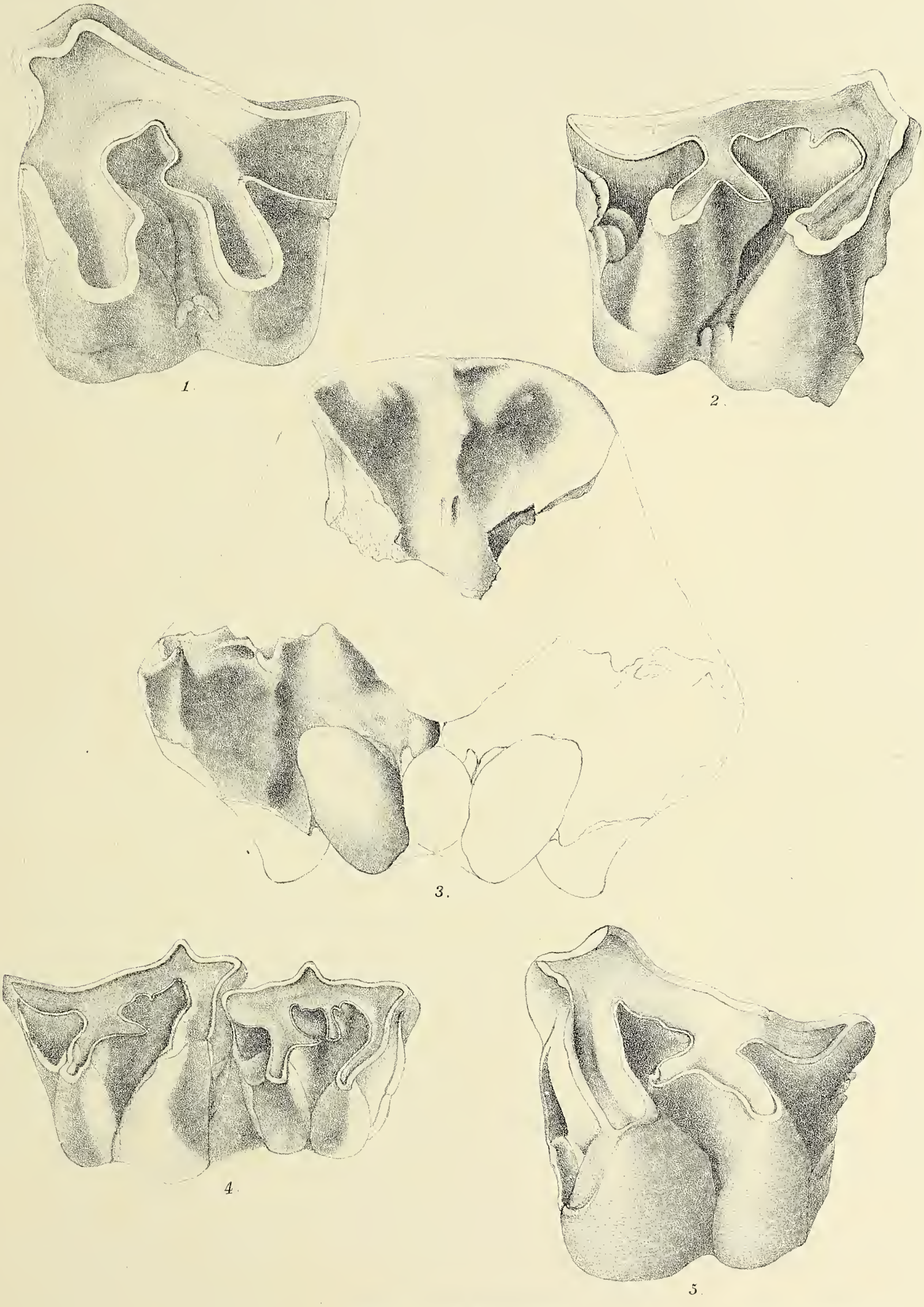

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PLATE VI.—RHINOCEROS AND ACEROTHERIUM.

Fig. ... 1. Rhinoceros sivalensis, *Falc. and Caut.:* 3rd lower molar; right side. Pinjor—Siwaliks. No. $\frac{S}{65}$.

Fig. ... 2. Acerotherium perimense, *Falc. and Caut.:* 1st upper molar; left side. Gadari—Siwaliks. No. 55.

Fig. ... 3. Rhinoceros, *n. sp. ?* lower molar; right side. Attock—Nahans (?).

Fig. ... 4. Rhinoceros platyrhinus, *Falc. and Caut.:* lower premolar; right side. Siwaliks.

Fig. ... 5. Acerotherium perimense, *Falc. and Caut.:* upper molars; right side. Perim Island. A. S. B. No. $\frac{P.I.}{30}$.

Fig. ... 6. Rhinoceros (*sp.*): upper premolar; left side. Manchhar beds—Sind. No. G. $\frac{280}{6}$.

Fig. ... 7. Rhinoceros *n. sp. ?* 1st lower molar; right side. Siwaliks. A. S. B. No. $\frac{S.}{322}$.

Fig. ... 8. Rhinoceros palæindicus: lower molar; left side. Manchhar beds. Sind. No. 494.

Fig. ... 9. Rhinoceros (*sp.*): upper premolar; left side. Siwaliks. No. 174.

Fig. ... 10. Rhinoceros (*sp.*): 4th upper premolar; left side. Siwaliks. A. S. B. No. $\frac{S}{324}$

All the figures natural size.

[Reprint.]

PLATE VI.

Fig. 1. RHINOCEROS SIVALENSIS (?) Falc. & Caut. : 3rd lower true molar of the right side : Siwalik.

Fig. 2. ACEROTHERIUM PERIMENSE, Falc. & Caut.. : 3rd upper premolar of the left side : Siwalik : described in text as first true molar

Fig. 3. RHINOCEROS, sp.: lower molar of the right side : near Attock.

Fig. 4. RHINOCEROS PLATYRHINUS (?) Falc. & Caut. : lower premolar of the right side : Siwalik.

Fig. 5. ACEROTHERIUM PERIMENSE, Falc. & Caut. : 2nd and 3rd upper premolars of the left side : Perim Island : described in text as last premolar and first true molar.

Fig. 6. ACEROTHERIUM PERIMENSE, Falc. & Caut. : the 2nd (?) upper premolar of the righ side : Sind : described in text as left premolar of a *Rhinoceros*.

Fig. 7. RHINOCEROS, sp., 1st lower molar of the right side : Siwalik.

Fig. 8. RHINOCEROS PALÆINDICUS (?) Lower molar of the left side : Sind.

Fig. 9. RHINOCEROS sp. : upper premolar, or milk-molar of the left side, probably abnormal Siwalik.

Fig. 10. RHINOCEROS PLATYRHINUS (?) An anterior upper milk-molar of the right side : Siwalik.

All the figures natural size.

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PLATE VII.—CARNIVORA AND UNGULATA.

Fig. ... 1. VISHNUTHERIUM IRAVADICUM, *n. gen. nobis:* left ramus of mandible. Burma. No. 224. Inner view.

Fig. ... 2. Outer view of fig. 1.

Fig. ... 3. DORCATHERIUM MINUS, *n. sp. nobis:* 2nd and 3rd upper molars; right side. Asnot—Siwaliks. No. 1301. Inner view.

Fig. ... 4. DORCATHERIUM MAJUS, var. b., *n. sp. nobis:* upper molars; left side. Asnot—Siwaliks. No. 1307. Inner view.

Fig. ... 5. AMPHICYON PALÆINDICUS, *n. sp. nobis:* 2nd upper molar; right side. Kushalghar, near Attock. No. 497.

Fig. ... 6. Outer view of fig. 4.

Fig. ... 7. Outer view of fig. 3.

Fig. ... 8. AMPHICYON PALÆINDICUS, *n. sp. nobis:* lower carnassial, and last milk molar. Núrpúr—Siwaliks. No. 656. Outer view.

Fig. ... 9. DORCATHERIUM MAJUS, *n. sp. nobis:* 3rd upper molar; right side. Kushalghar, near Attock. No. 502. Inner view.

Fig. ... 10. Outer view of fig. 9.

Fig. ... 11. DORCATHERIUM, *sp.:* right upper molar. Kushalghar, near Attock. Nos. 502-6.

Fig. ... 12. Inner view of fig. 8.

Fig. ... 13. BRAMATHERIUM PERIMENSE, *Falc. and Caut.:* 1st and 2nd lower molars. Perim Island. A. S. B. No. $\frac{\text{P. I.}}{38}$. Outer view.

Fig. ... 14. CAMELOPARDALIS SIVALENSIS, *Falc. et nobis:* last lower premolar; right side. Lehri—Siwaliks. No. 39.

Fig. ... 15. CAMELOPARDALIS SIVALENSIS, *Falc. partim:* 1st and 2nd lower molars; right side. Lehri—Siwaliks. No. 39. Outer side.

All the figures natural size.

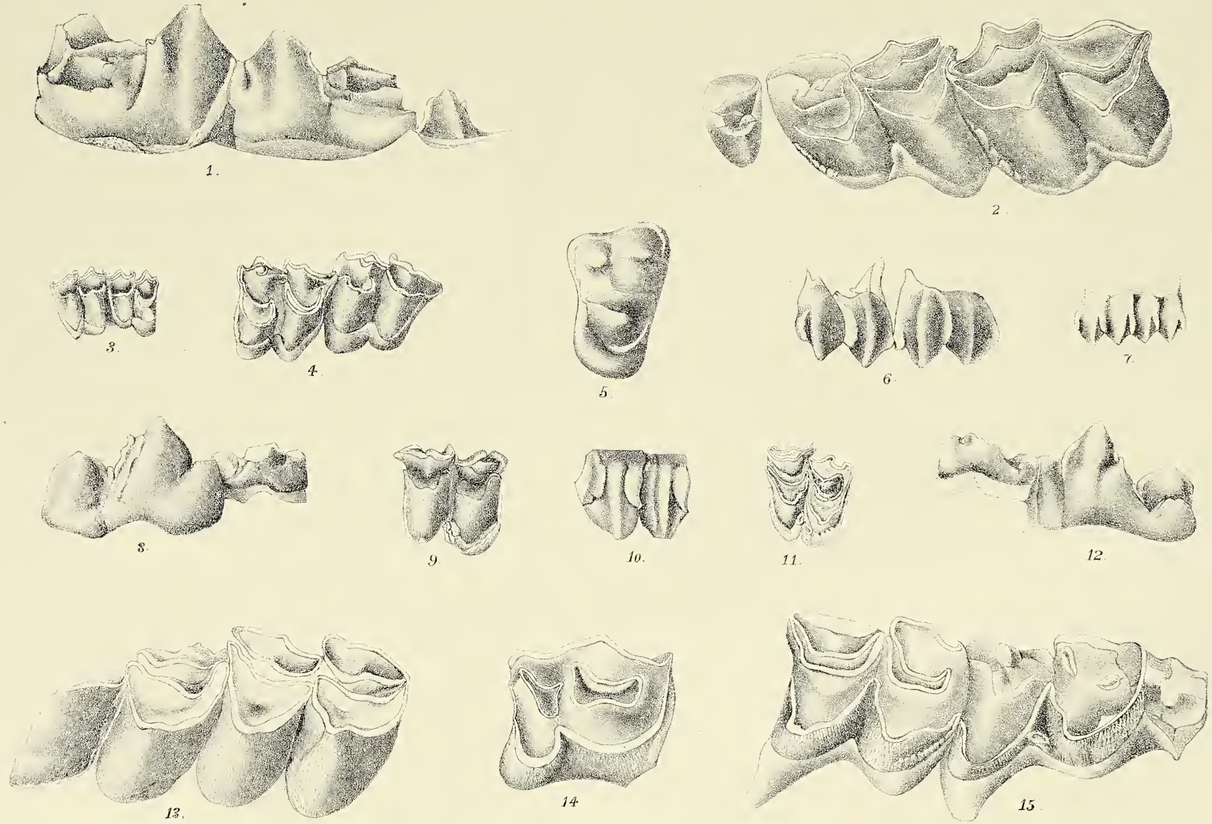

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PLATE VIII.—UNGULATA AND EDENTATA.

Fig. ... 1. Cervus triplidens, *n. sp. nobis:* 2nd and 3rd upper molars; right side. Siwaliks. No. $\frac{S.}{38}$. Inner view.

Fig. ... 2. Outer view of fig. 1.

Fig. ... 3. Cervus simplicidens, *n. sp. nobis:* 2nd and 3rd upper molars; left side. Siwaliks. No. 48. Inner view.

Fig. ... 4. Cervus latidens, *n. sp. nobis:* lower molar; right side. Padrí—Siwaliks. No. 23. Inner view.

Fig. ... 5. Cervus, *sp.:* 2nd and 3rd lower molars; right side. Padrí—Siwaliks. No. $\frac{S.}{157}$. Outer view.

Fig. ... 6. Outer view of fig. 4.

Fig. ... 7. Cervus latidens, *n. sp. nobis:* last upper molar; right side. Asnot—Siwaliks. No. 1420. Outer view.

Fig. ... 8. Listriodon pentapotamiæ, *Falc. sp.:* upper molar; right side. Kushalghar, near Attock. No. 499.

Fig. ... 9. Listriodon pentapotamiæ, *Falc. sp.:* upper molar; right side. Asnot—Potwar. No. 813.

Fig. ... 10. Inner view of fig. 7.

Fig. ... 11. Manis sindiensis, *n. sp. nobis:* second phalange third digit of manus. Lateral view.

Fig. ... 12. View of distal surface of fig. 11.

Fig. ... 13. View of anterior surface of fig. 11.

Fig. ... 14. View of proximal surface of fig. 11.

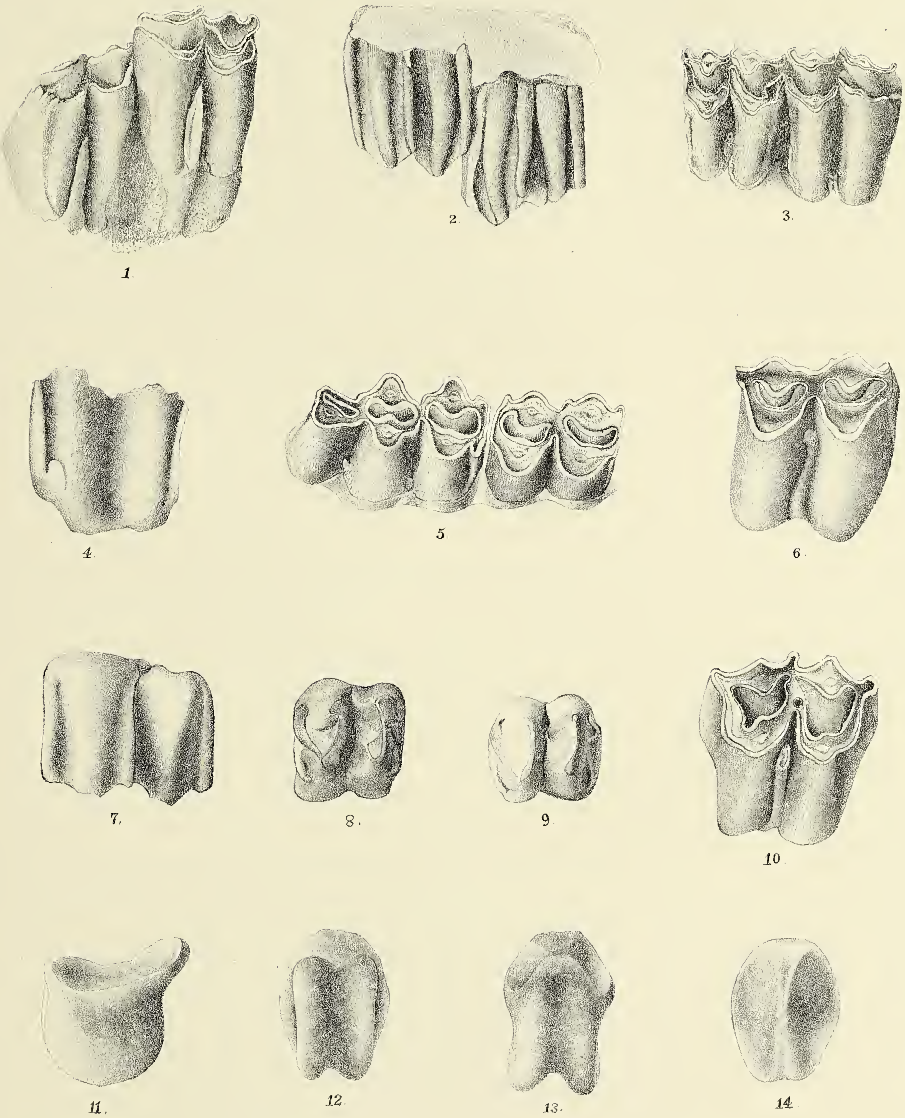

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PLATE IX.—DINOTHERIUM AND SANITHERIUM.

Fig. ... 1. DINOTHERIUM PENTAPOTAMIÆ, *Falc.:* first upper premolar; right side; crown-surface, from the inner side. Kushalghar, near Attock. No. 505.

Fig. ... 2. DINOTHERIUM PENTAPOTAMIÆ, *Falc.:* first upper molar; right side; crown-surface, from the inner side. Kushalghar, near Attock. No. 506.

Fig. ... 3. DINOTHERIUM PENTAPOTAMIÆ, *Falc.:* second upper molar; right side; crown-surface, from the inner side. Kach. No. G 062.

Fig. ... 4. DINOTHERIUM PENTAPOTAMIÆ, *Falc.:* first upper molar; right side Kach. No. G 062.

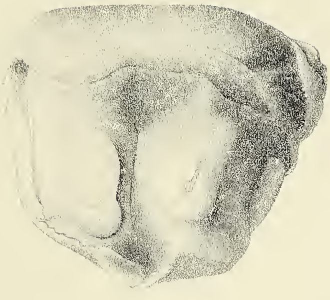
Fig. ... 5. DINOTHERIUM PENTAPOTAMIÆ, *Falc.:* first lower molar; left side. Sind. Nos. $\frac{G.\,225}{7}$.

Fig. ... 6. SANATHERIUM SCHLAGINTWEITII, *Von Meyer:* second and part of third lower molars; left side. Kushalghar. (Palæontographica, vol. 15, pl. II, fig. 9.)

Fig. ... 7. Outer view of fig. 6.

Fig. ... 8. SANITHERIUM SCHLAGINTWEITII, *Von Meyer* (*Sus pusillus,* Falc.): part of third lower molar; right side. Kushalghar. No. 500.

Fig. ... 9. Outer view of fig. 8.



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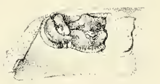

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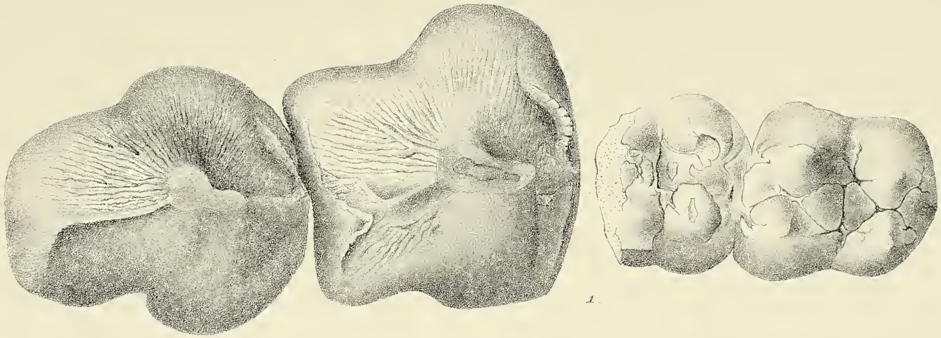
PLATE X.—TETRACONODON.

Fig. ... 1. TETRACONODON MAGNUM, *Falc.* : right ramus of mandible ; upper view. Asnot—Siwaliks. No. 828.

Fig. ... 2. Inner view of penultimate premolar of same specimen.

Fig. ... 3. Outer view of same specimen.



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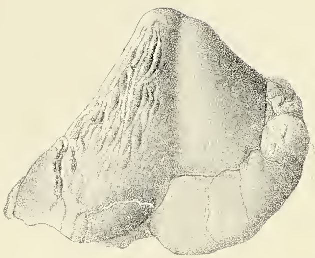

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[Reissue.]

PLATE X.

Tetraconodon magnum, Falconer.

Molar and part of premolar dentition of right ramus of mandible: from the Punjab.

a. Upper view.

b. Inner view of penultimate premolar.

c. Outer view.

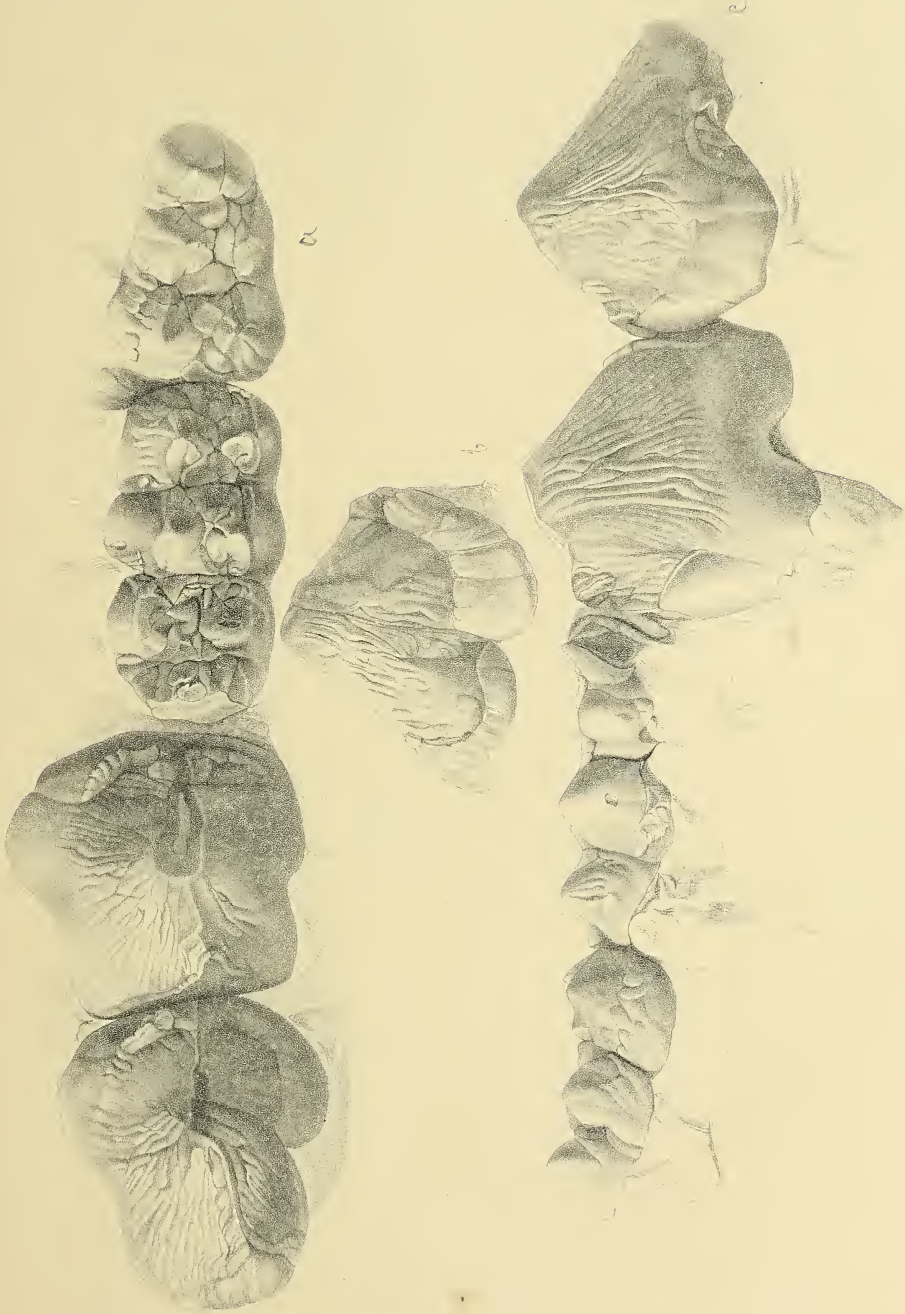

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PLATE XI.

Fig. 1. Bos NAMADICUS, F. & C.: front view of cranium, $\frac{1}{5}$ nat. size. Nerbudda Valley. No. 266, Ind. Mus.

Fig. 2. Lateral view of same cranium, $\frac{1}{5}$ nat. size.

Figs. 3 & 4. Sections of horn-core, 3 at tip, 4 at base.


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PLATE XII.

Fig. 1. Bos ACUTIFRONS, n. sp. nobis: front view of cranium, $\frac{1}{6}$ nat. size. Padrí, Siwalik. No. $\frac{S}{117}$, Ind. Mus.: 1 *a*, section of horn-core at tip; 1 *b*, at base.

Fig. 2. Bos PLANIFRONS, n. sp. nobis: front view of cranium, $\frac{1}{3}$ nat. size. Kangrá, Siwalik. No. $\frac{S}{118}$, Ind. Mus.

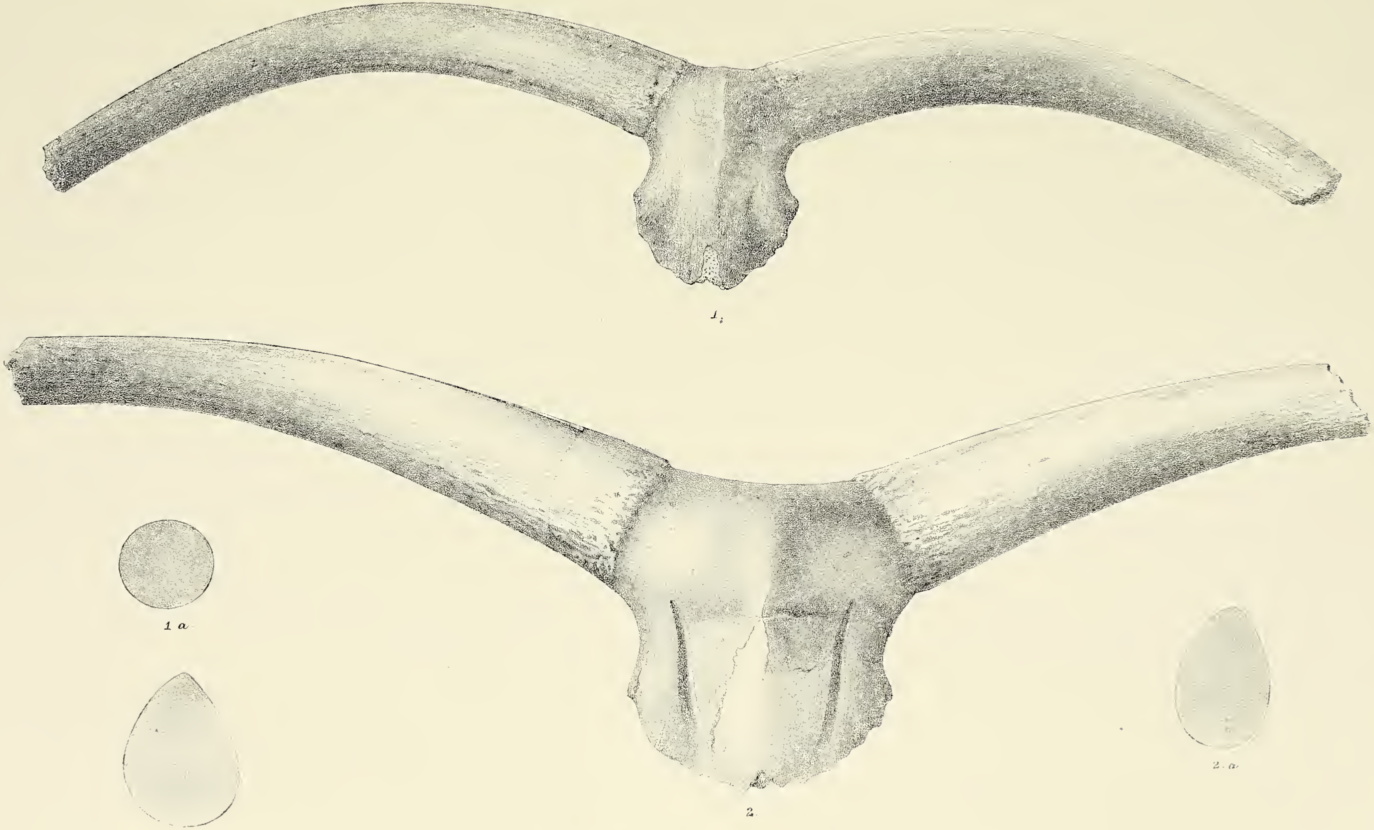

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PLATE XIII.

Bos acutifrons, n. sp. nobis : larger view of specimen drawn in Plate XII, $\frac{1}{3}$ nat. size.

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PLATE XIV.

Bos PLATYRHINUS, n. sp. nobis: front view of lower half of cranium, $\frac{1}{2}$ nat. size. Umb, Siwalik. No. $\frac{S}{14}$, Ind. Mus.

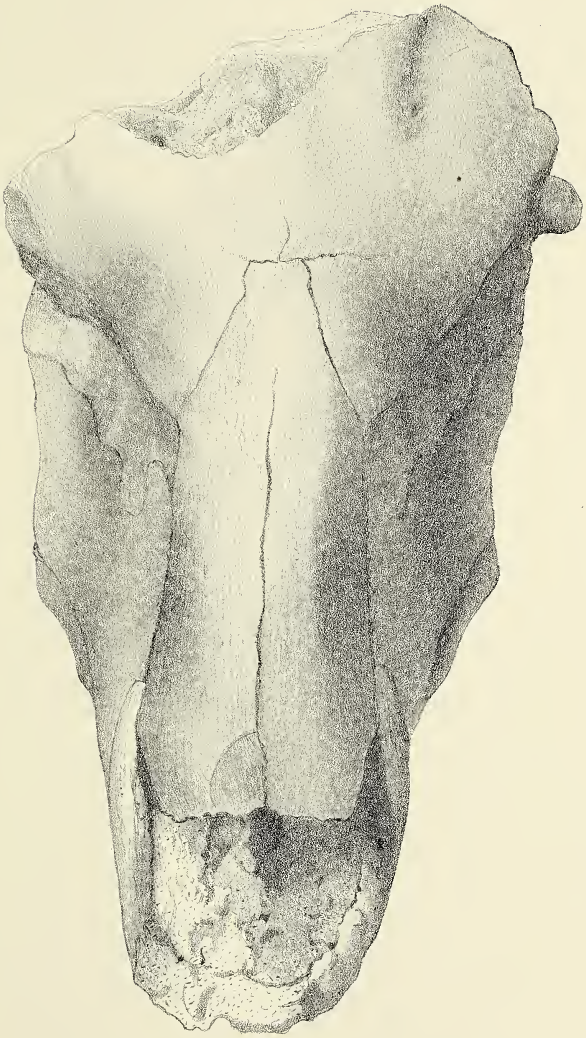

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PLATE XV.

Bison sivalensis, F. & C., sp.: front view of cranium and section of horn-core, $\frac{1}{2}$ nat. size. Siwalik, No. $\frac{S}{119}$, Ind. Mus.

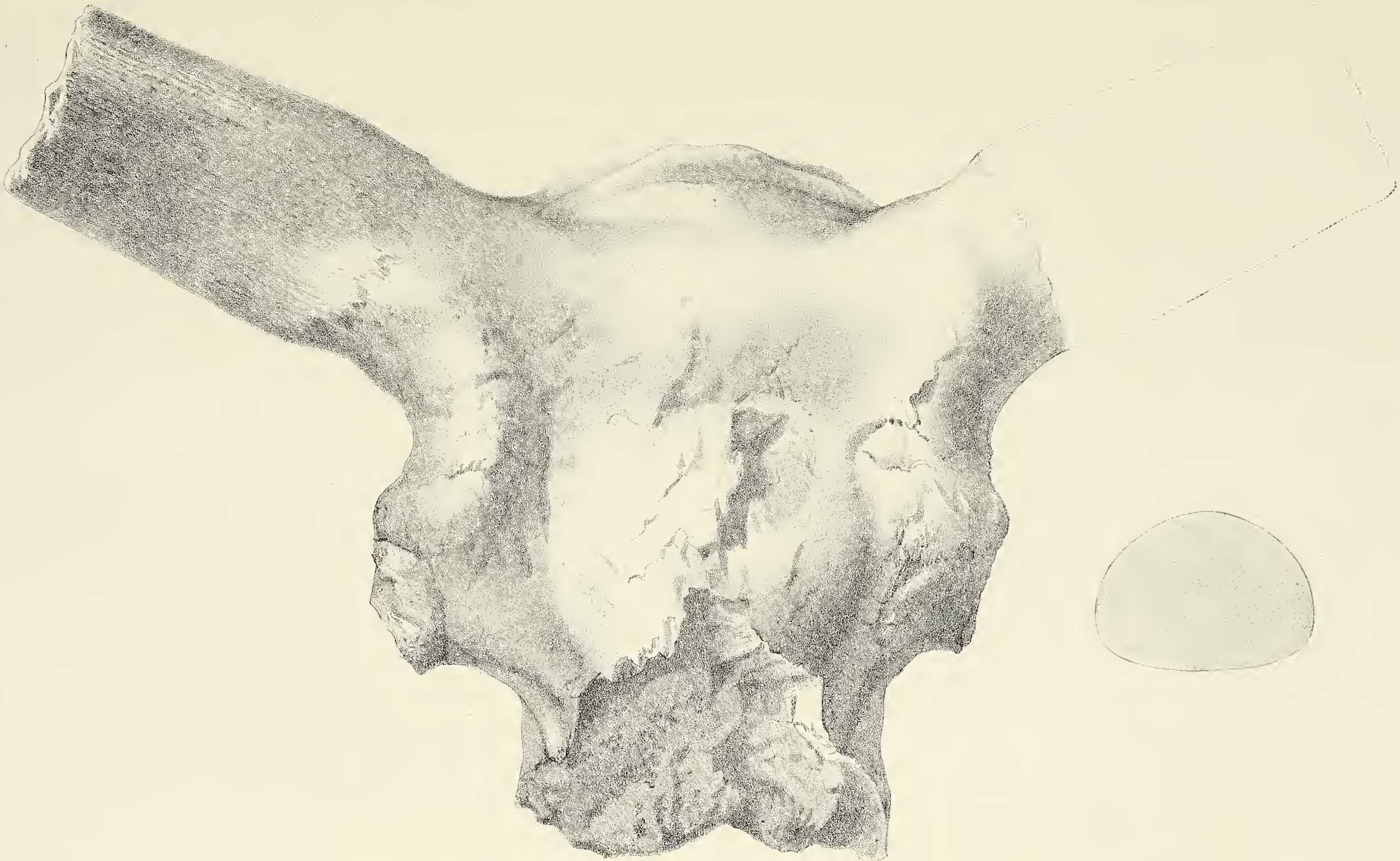

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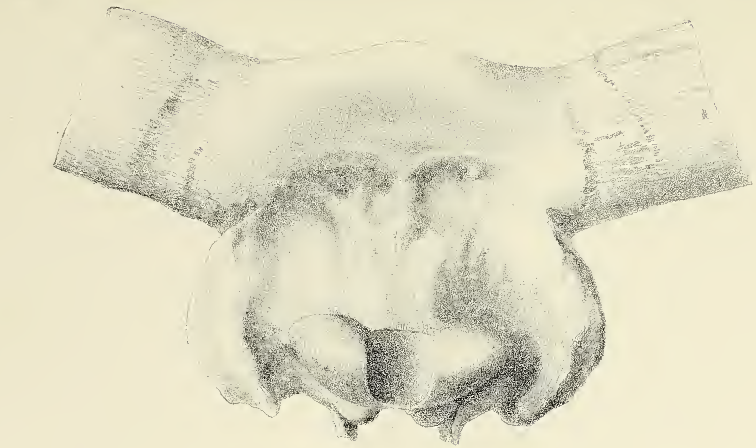
PLATE XVI.

Fig. 1. Bos NAMADICUS, F. & C.: occipital view of cranium figured in Plate XI, $\frac{1}{3}$ nat. size.

Fig. 2. Bos ACUTIFRONS, n. sp. nobis: occipital view of cranium figured in Plate XII, fig. 1, $\frac{1}{3}$ nat. size.

Fig. 3. Bos NAMADICUS, F. & C.: occipital view of specimen figured in F. A. S., Plate G, fig. 1. *a*. Nerbudda.

Fig. 4. Bos PLANIFRONS, n. sp. nobis: occipital view of cranium figured in Plate XII, fig. 2, $\frac{1}{3}$ nat. size.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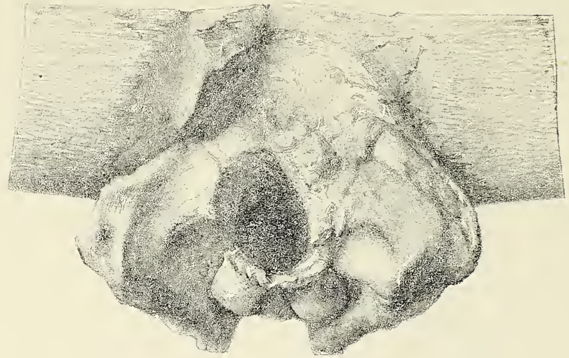
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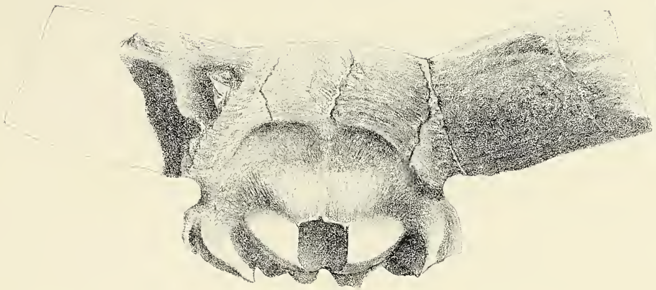
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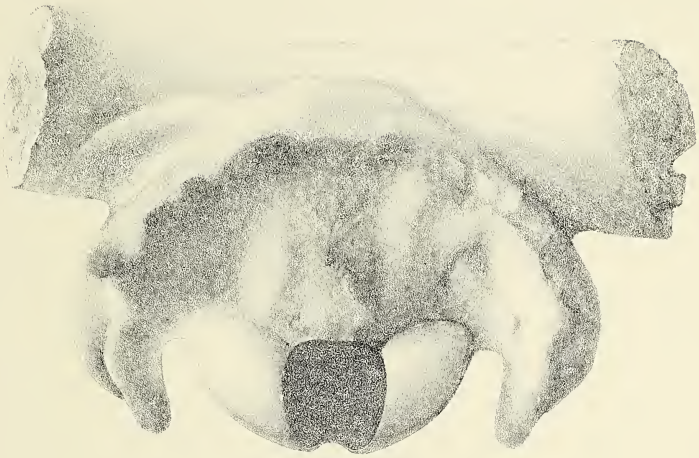
PLATE XVII.

Fig. 1. Bison Sivalensis, F. & C., sp.: occipital view of specimen figured in Plate XV, $\frac{1}{2}$ nat. size.

Fig. 2. Bubalus palæindicus, F. & C.: occipital view of specimen figured in Plate XIX, $\frac{1}{3}$ nat. size.



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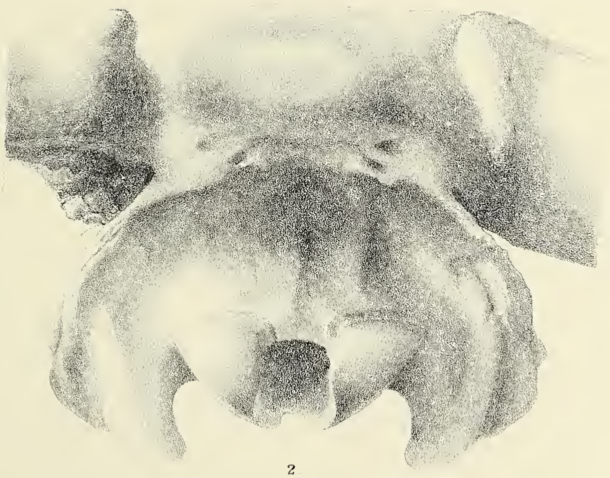

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PLATE XVIII.

Bubalus platyceros, n. sp. nobis: Fig. 1, front view of cranium, $\frac{1}{4}$ nat. size; Fig. 2, occipital view, $\frac{1}{2}$ nat. siz. Siwalik, No. $\frac{S}{120}$. Ind. Mus.

Fig. 3. Section of horn-core at base.

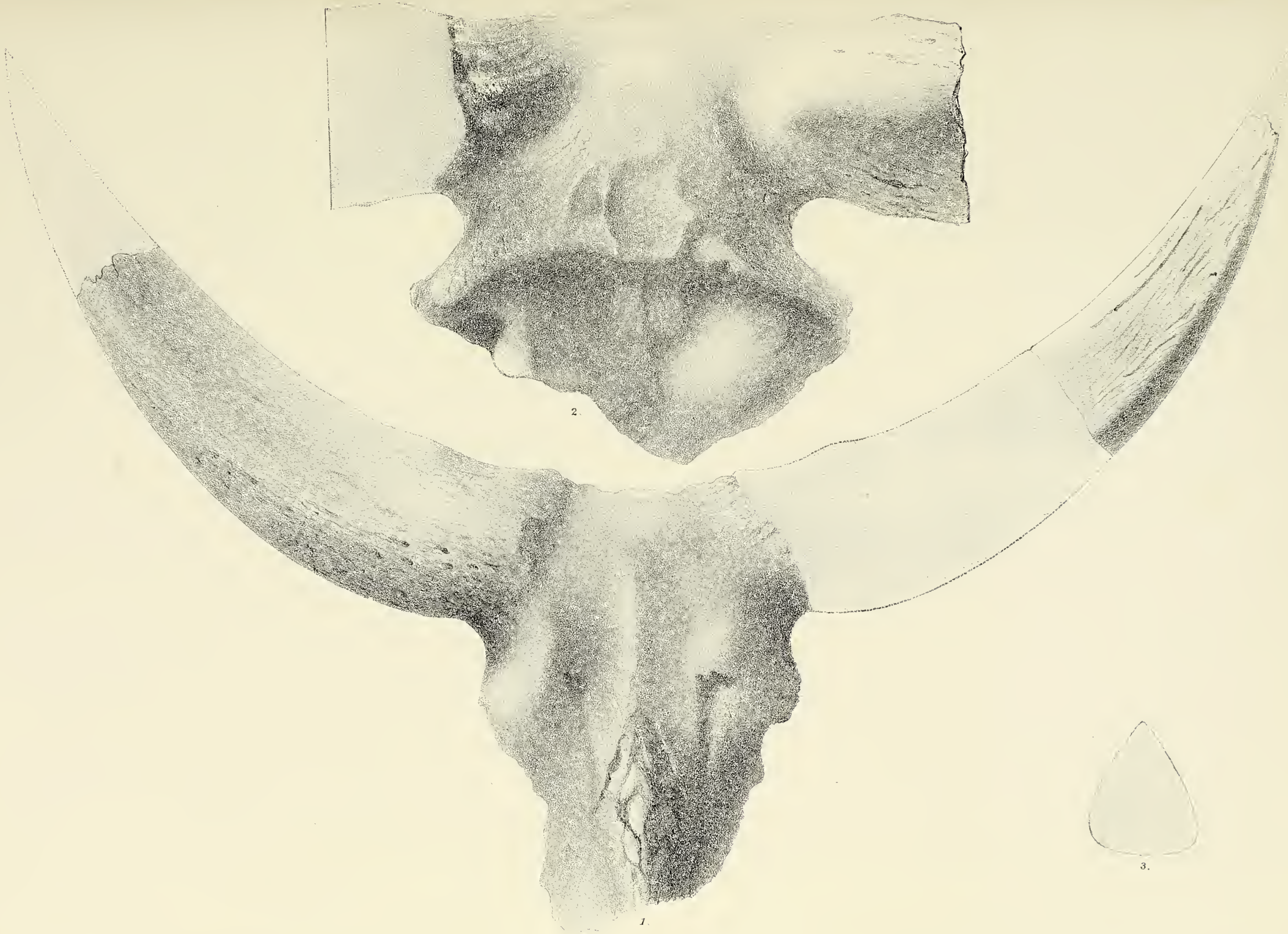

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PLATE XIX.

Bubalus palæindicus, F. & C.: front view of cranium, $\frac{1}{3}$ nat. size. Nerbudda Valley.

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PLATE XX.

PERIBOS OCCIPITALIS, Falconer, sp. (?) : front view of cranium, $\frac{1}{2}$ nat. size. No. $\frac{S}{151}$ (A. S. B.) Siwalik.

[Reissue.]

PLATE XX.

HEMIBOS OCCIPITALIS, Falc., sp.; front view of cranium of male trochoceros form; one-half natural size; Siwalik. Described in text as *Peribos occipitalis.*

Synonyms: *Probubalus triquetricornis*, Rüt.
Hemibos triquetriceros, Falc.

1 *a*. Section of base of horn-core.

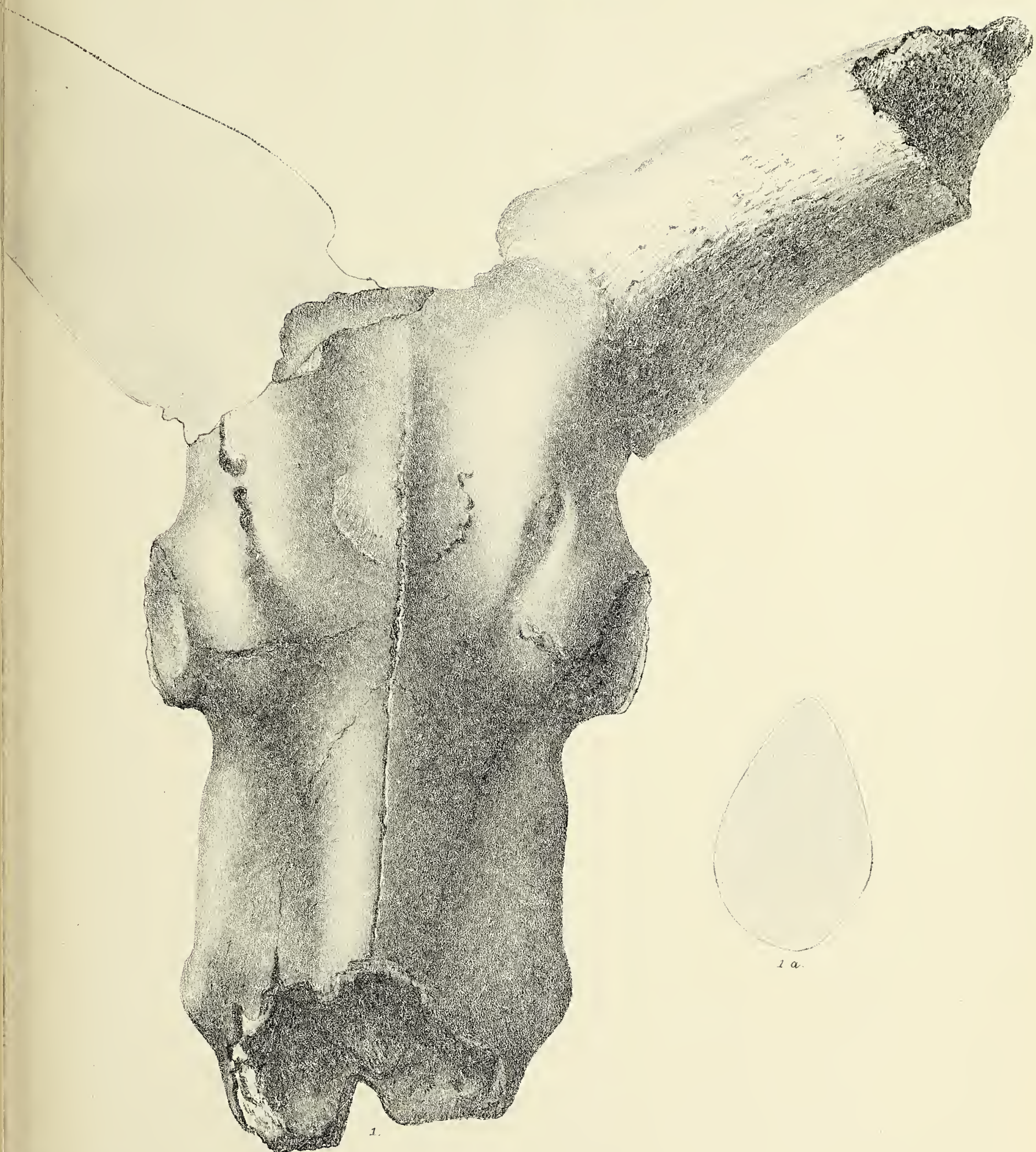

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PLATE XXI.

Fig. 1. AMPHIBOS ACUTICORNIS, F. & C.: lateral view of cranium, ½ nat. size. Siwalik.

Fig. 2. PERIBOS OCCIPITALIS, Falconer, sp. (?) : lateral view of cranium figured in Plate XX, ½ nat. size.

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PLATE XXI A.

Hemibos occipitalis, Falc. sp.; front view of nearly perfect cranium of male trochoceros form; one-half natural size; Siwalik.

Jodu Nath Das, Lithᵃ. Printed at Geol: Survey Office

PLATE XXI B.

Hemibos acuticornis, Falc. sp.; front view of specimen figured in Plate XXI, fig. 1.

Jodu Nath Das, Lithᵈ. Printed at Geol: Survey Office.

[Reissue.]

PLATE XXI.

Fig. 1. Hemibos acuticornis, Falc. sp.; profile view of cranium of a young female; one-half natural size; Siwalik. Described in text as *Amphibos acuticornis*.

Fig. 2. Hemibos occipitalis, Falc. sp.; profile view of specimen figured in preceding plate.

J. Schaumburg, Lithd. Printed at Geol: Survey Office

[Reissue.]

PLATE XXII.

Hemibos acuticornis, Falc. sp.; front view of cranium of an old male, of the triangular horned variety; one-half natural size; Siwalik. Described in text as *Hemibos triquetriceros.*

Synonym: *Amphibos acuticornis,* Falc. and Rüt.

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[Reissue.]

PLATE XXIII.

Hemibos acuticornis, Falc. sp.; profile view of specimen figured in last plate.

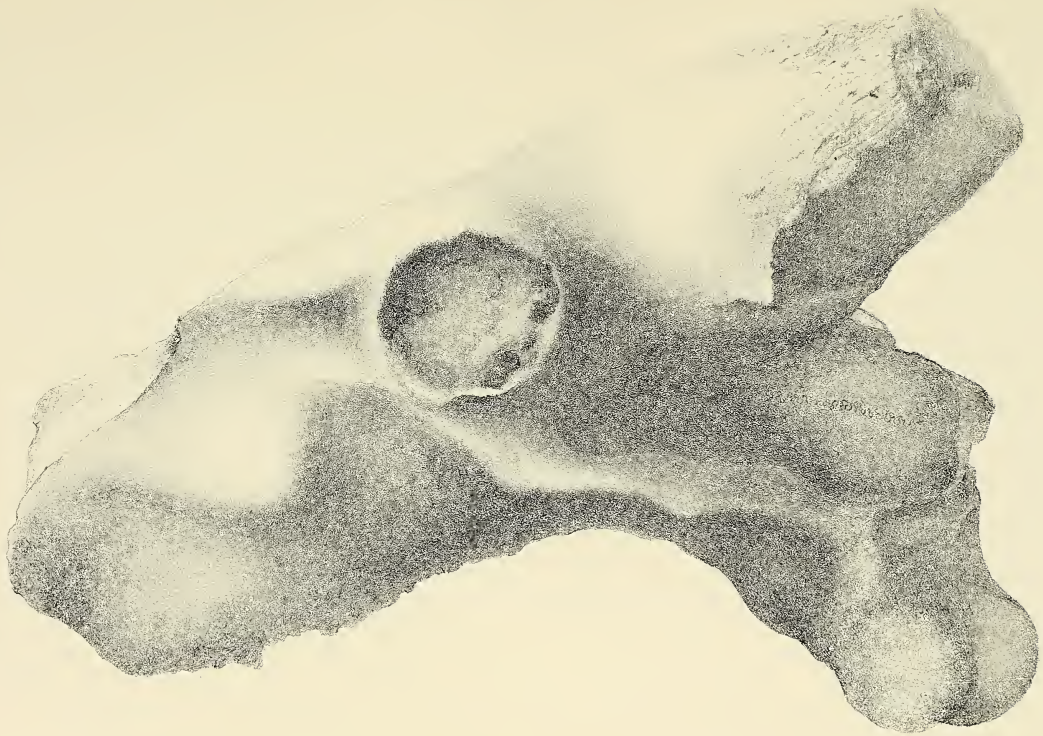

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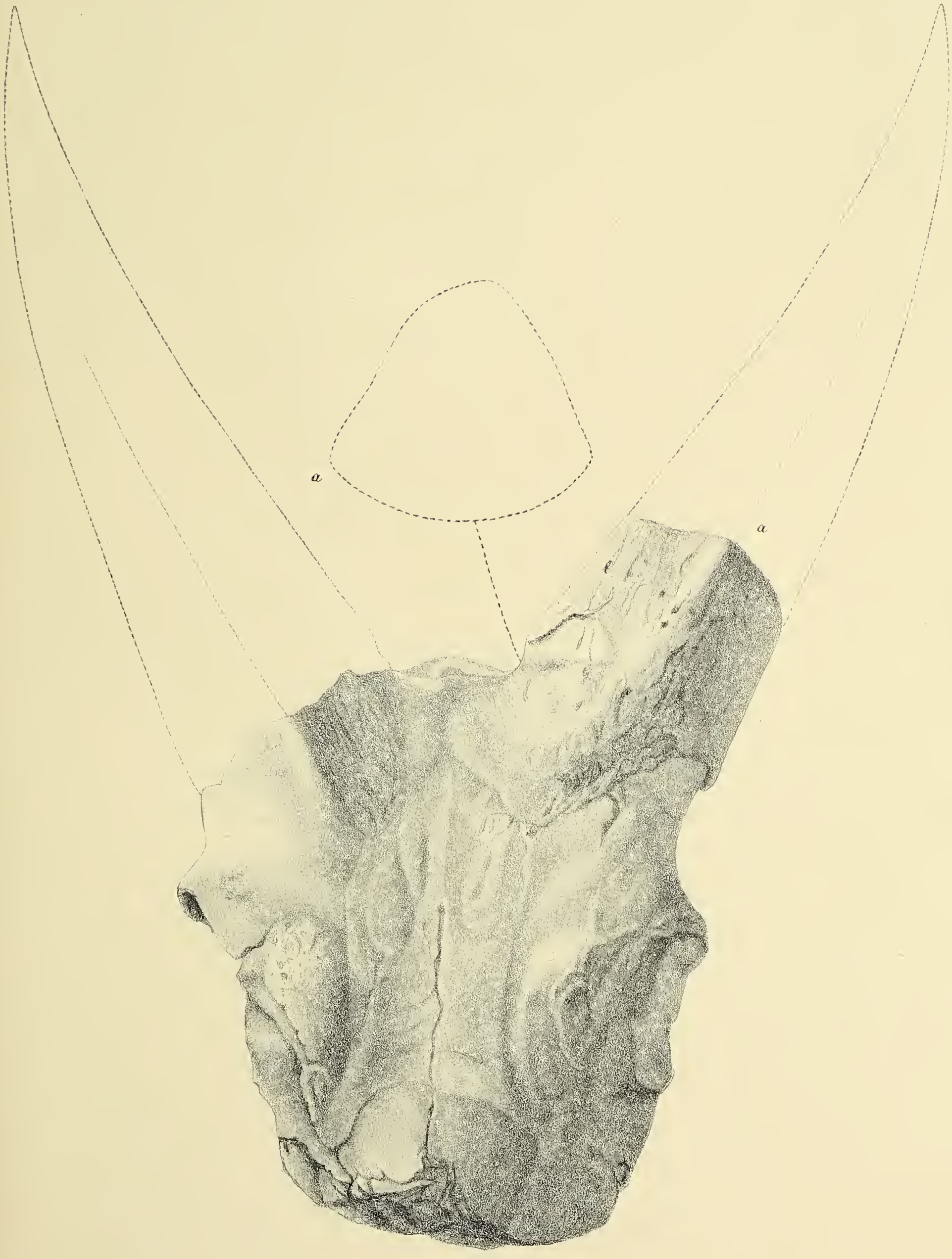
PLATE XXIII A.

Hemibos acuticornis, Falc. sp.; front view of a male skull somewhat younger than specimen figured in Plate XXII, and with less markedly triangular horns; one-half natural size; Siwalik.

a. Section of base of horn-core.



Jodu Nath Das, Lith.^r Printed at Geol: Survey Office.

PLATE XXIV.

Amphibos acuticornis, F. & C.: front view of cranium, $\frac{1}{2}$ nat. size. Padrí, Siwalik No. $\frac{S}{151}$, Ind. Mus.

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[Reissue.]

PLATE XXIV.

Hemibos occipitalis, Falc. sp.; front view of cranium of normal (?) male form; one-half natural size; Siwalik. Described in text as *Amphibos (Hemibos) acuticornis.*

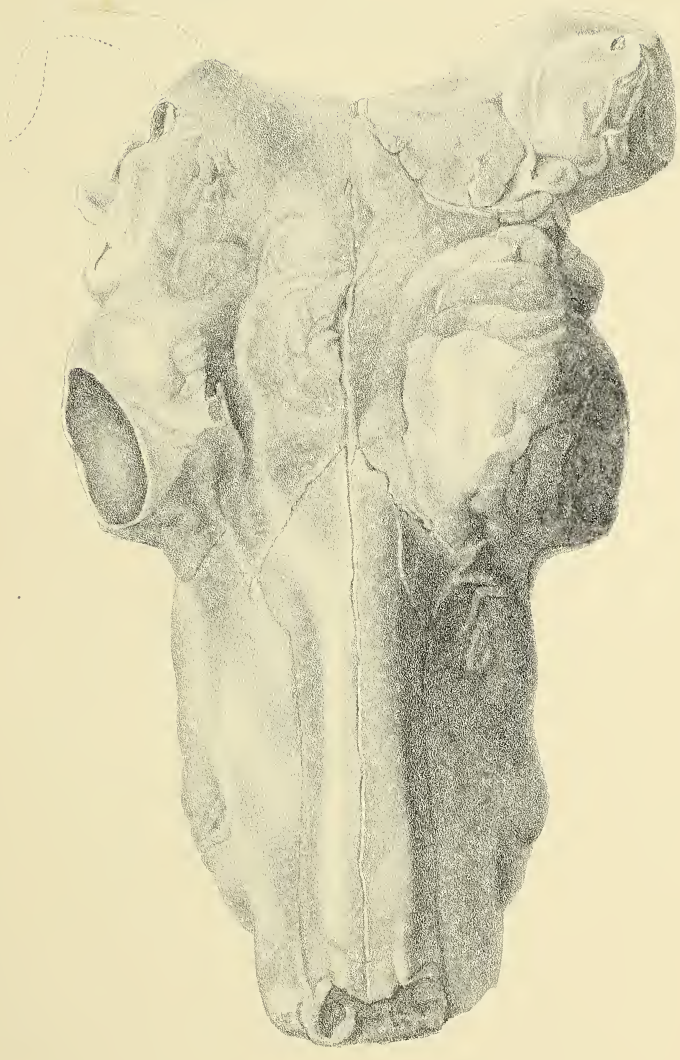

PLATE XXV.

Fig. 1. Antilope Sivalensis, n. sp. nobis: lateral view of cranium, ½ nat. size. Siwalik, No. 47, Ind. Mus.

Fig. 2. Antilope Sivalensis, n. sp. nobis: front view of preceding specimen.

Fig. 3. Antilope patulicornis, n. sp. nobis: front view of part of cranium, ½ nat. size. Siwalik, No. 46.

Fig. 4. Antilope porrecticornis, n. sp. nobis: front view of left frontal and horn-core (right side restored in outline), ½ nat. size. Potwar District, Siwalik, No. 1653.

TERTIARY MAMMALIA

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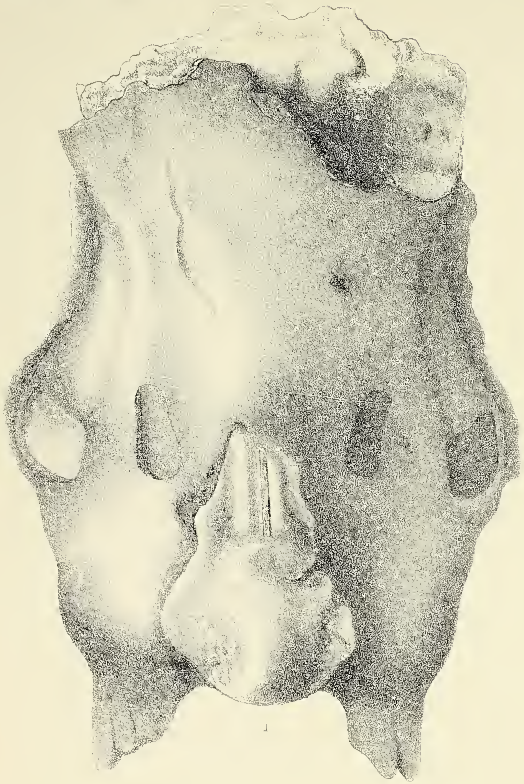
PLATE XXVI.

Hydaspitherium megacephalum, n. gen. nobis: lateral and front views of cranium. Potwar District, Siwalik, $\frac{1}{3}$ nat. size, Ind. Mus.



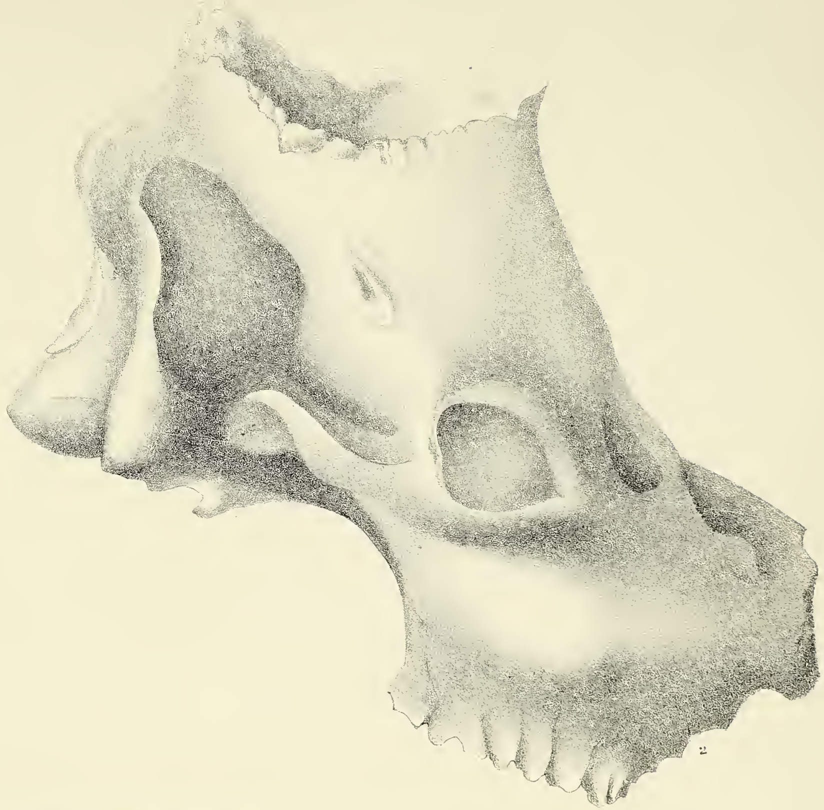


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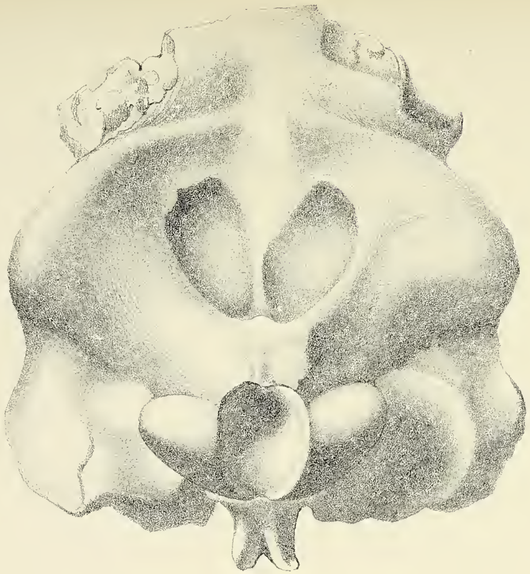
PLATE XXVII.

Figs. 1 & 2. HYDASPITHERIUM MEGACEPHALUM, n. gen. nobis: palatal and occipital views of cranium figured in Plate XXVI, $\frac{1}{3}$ nat. size.

Fig. 3. Last left upper molar of *Sivatherium giganteum,* nat. size.

Fig. 4. Corresponding tooth of *Hydaspitherium megacephalum,* nat. size.



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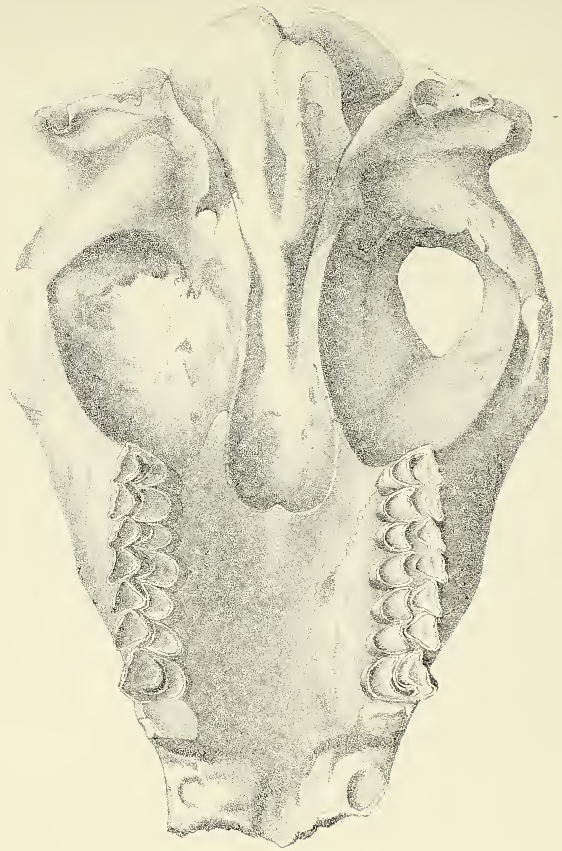

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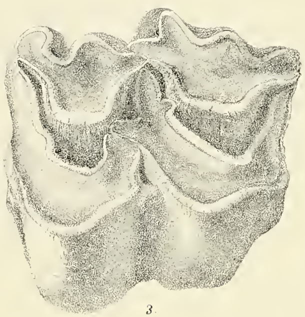

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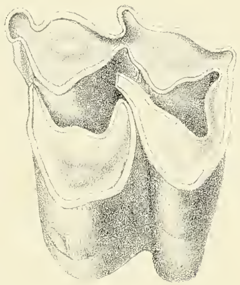

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PLATE XXVIII.

Fig. 1. Capra Sivalensis, n. sp. nobis: front view of portion of cranium, ½ nat. size: original specimen in the British Museum. Siwalik.

Fig. 2. Lateral view of last specimen.

Fig. 3. Capra, sp.: fragment of left horn-core, ½ nat. size. Potwar District, Siwalik, No. 1698.

Fig. 4. Capra perimensis, n. sp. nobis: lateral view of portion of cranium and horn-cores, ½ nat. size. Perim Island, No. $\frac{P.I.}{50}$ (A. S. B.)

Fig. 5. Front view of last specimen, ½ nat. size.

1. 2. 3. 4. 5.

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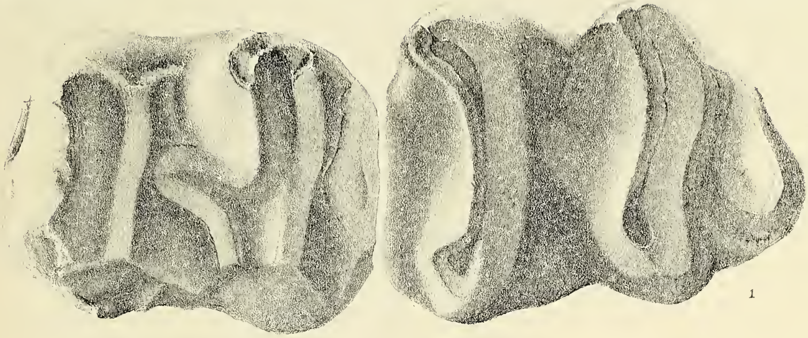
PLATE XXIX.

Dinotherium pentapotamiæ, Falconer et nobis.

Fig. ... 1. The second and third left lower true molars: Siwalik.

Figs. 2 & 3. The last premolar, the first true molar, and half of the second true molar of the left side: from Kúshalghar on the Indus.

Both specimens are represented of the natural size, and are viewed from the outer side.



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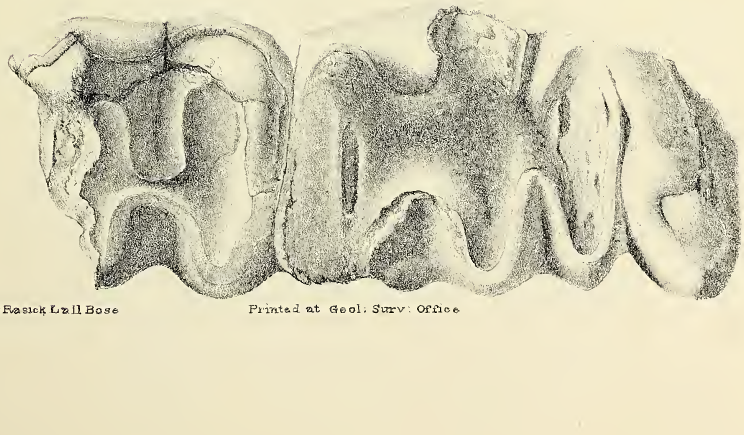

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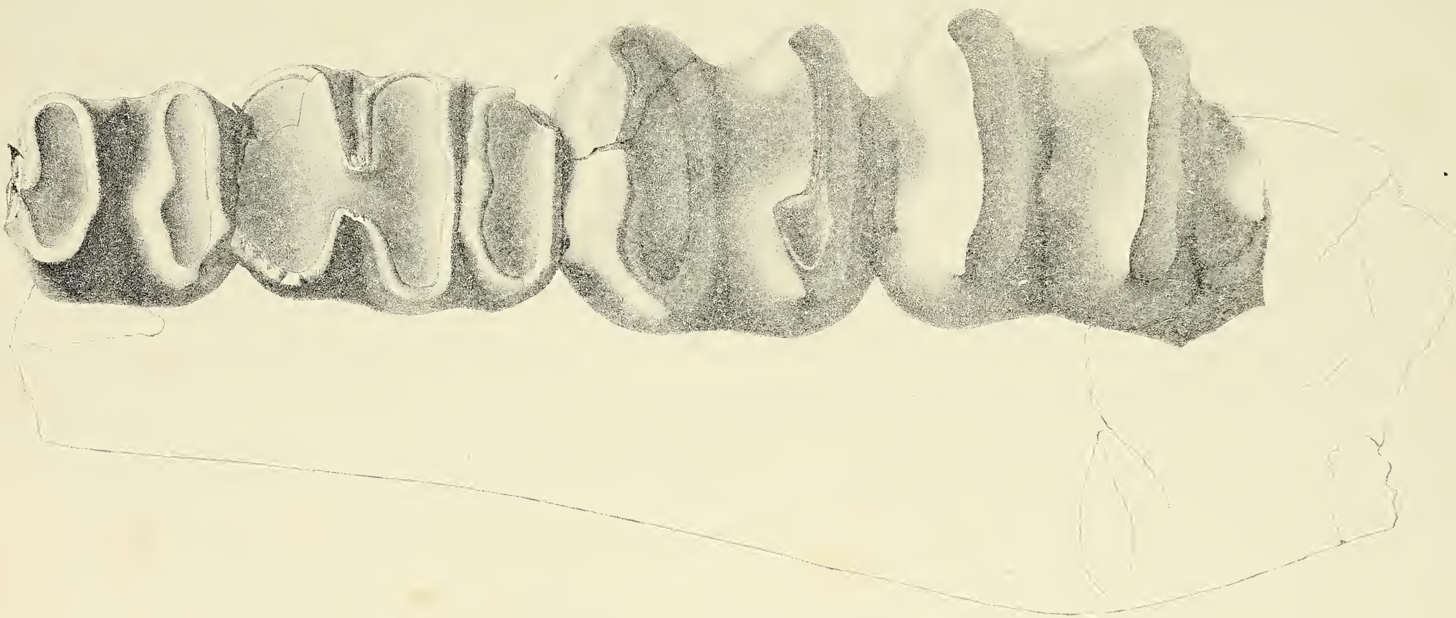
PLATE XXX.

Dinotherium pentapotámiæ, Falconer et nobis.

A portion of the left ramus of the mandible containing the last premolar and the three true molars. The specimen is from the Láki hills of Sind; and is represented from the outer side, of the natural size.



Lith by Rasick Lall Bose

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PLATE XXXI.

Fig. ... 1. Dinotherium indicum, Falconer. Hinder ridge of second right upper true molar: from (?) Dehra Ghazi Khan.

Fig. ... 2. Dinotherium indicum, Falconer. First left lower true molar: from Sind.

Fig. ... 3. Dinotherium pentapotamiæ, Falconer et nobis. Last left upper premolar: from Sind.

Fig. ... 4. Dinotherium sindiense, nobis. Part of right ramus of the mandible: from Sind.

All the specimens are represented of the natural size. The upper molars are viewed from the inner, and the lower from the outer side.

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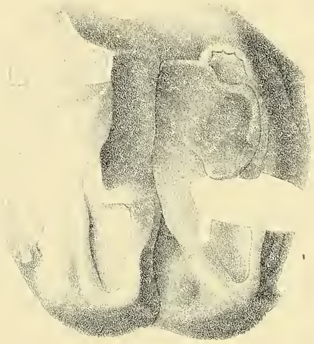

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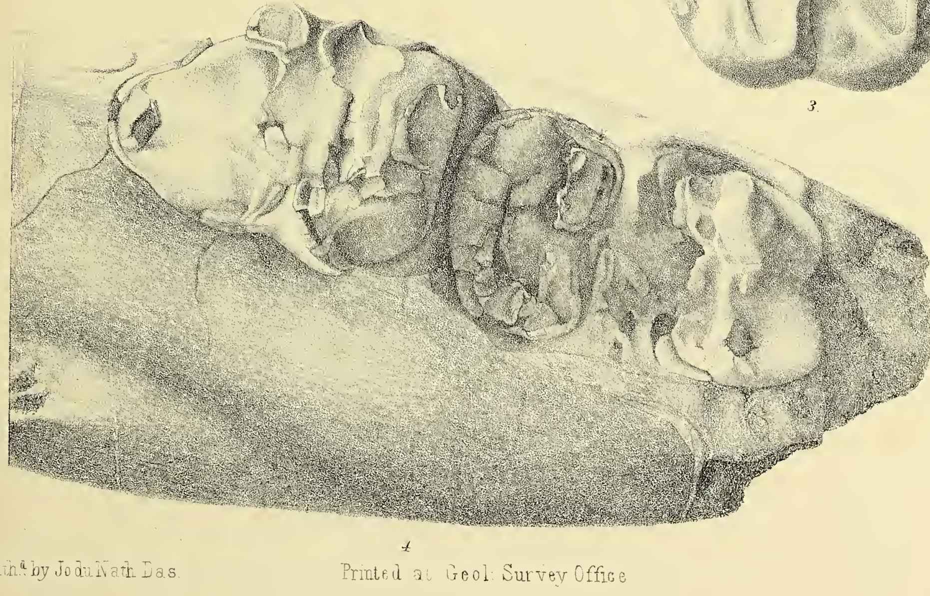

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PLATE XXXII.

MASTODON (TRILOPHODON) FALCONERI, nobis.

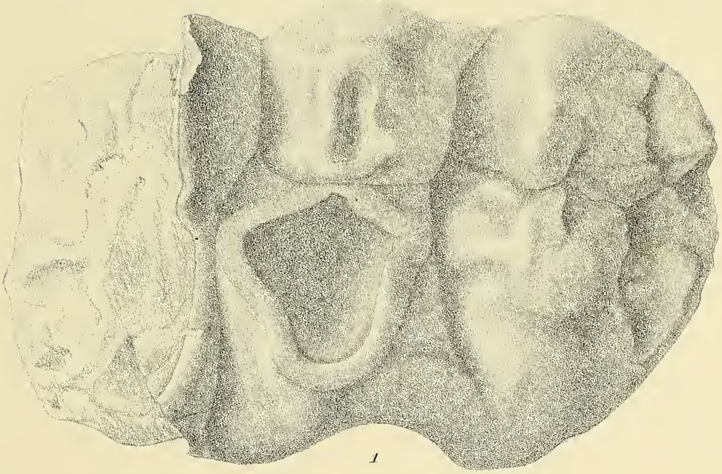
Fig. ... 1. Second left upper true molar: from the Punjab.

Fig. ... 2. Second left upper milk-molar: from a young cranium found in the Punjab.

Fig. ... 3. Third left upper milk-molar: from the same cranium.

Fig. ... 4. First left upper true molar: from the Punjab.

All the specimens are represented of the natural size, and are viewed from the inner side.



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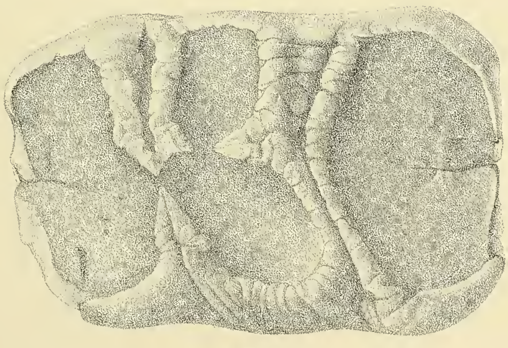

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PLATE XXXIII.

MASTODON (TRILOPHODON) FALCONERI, nobis.

Fig. ... 1. Part of right ramus of mandible, with second true molar: from the Punjab.

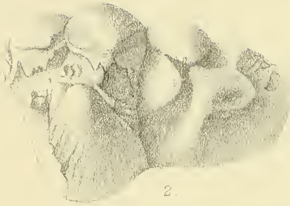
Fig. ... 2. Second right lower milk-molar: from the Punjab.

Fig. ... 3. First right lower true molar: from Sind.

Fig. ... 4. Second right lower true molar: from the jaw represented in fig. 1.

All the specimens are viewed from the outer side: fig. 1 is $\frac{1}{4}$ the natural size: the rest are of the natural size.

1



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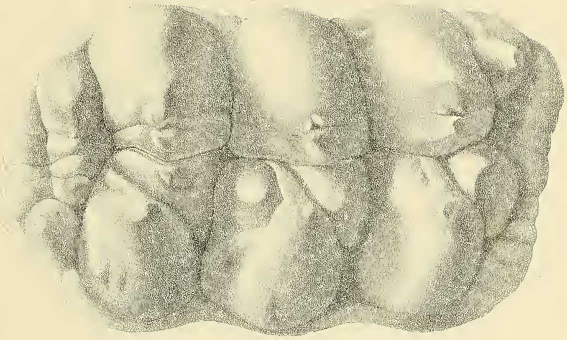

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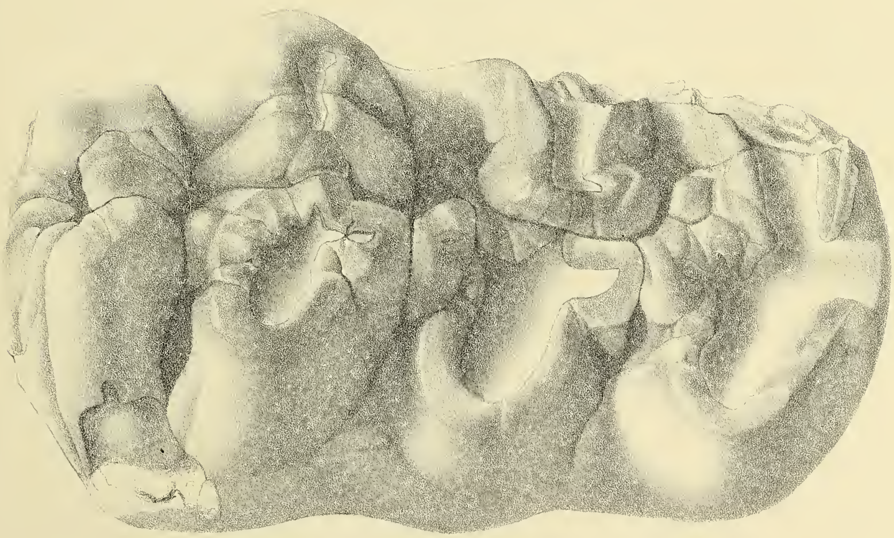

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Lithᵒ by Jodu Nath Das   Printed at Geol: Survey Office.

PLATE XXXIV.

MASTODON (TRILOPHODON) PANDIONIS, Falconer.

Fig. 1. The second right lower true molar: from the Punjab.

Fig. 2. The third right lower true molar, from the same jaw as the last.

Both molars are represented of the natural size, and are viewed from the outer side.

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2.

Jodu Nath Das. Lith^d

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PLATE XXXV.

Mastodon (Trilophodon) pandionis, Falconer.

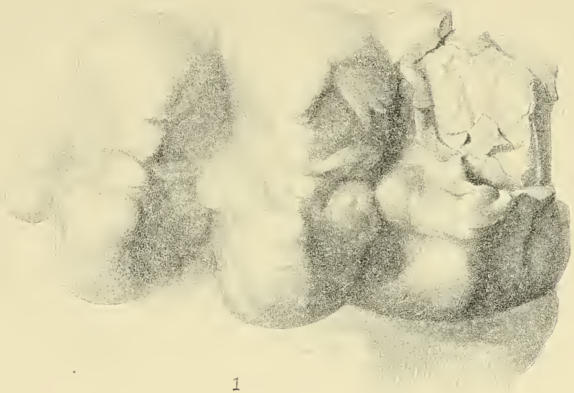
Fig. 1. The first right lower true molar: from the Punjab.

Fig. 2. The last left lower premolar?: from Sind.

Fig. 3. The second left upper milk-molar: from the Punjab.

Fig. 4. The third right lower true molar: from the Punjab.

All the specimens are represented of the natural size. The upper molar is viewed from the inner side, and the lower molars are viewed from the outer side.



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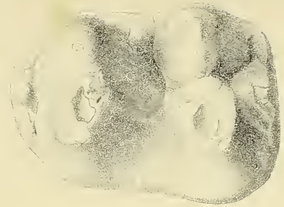

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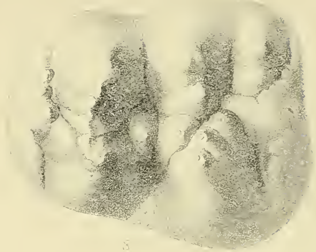

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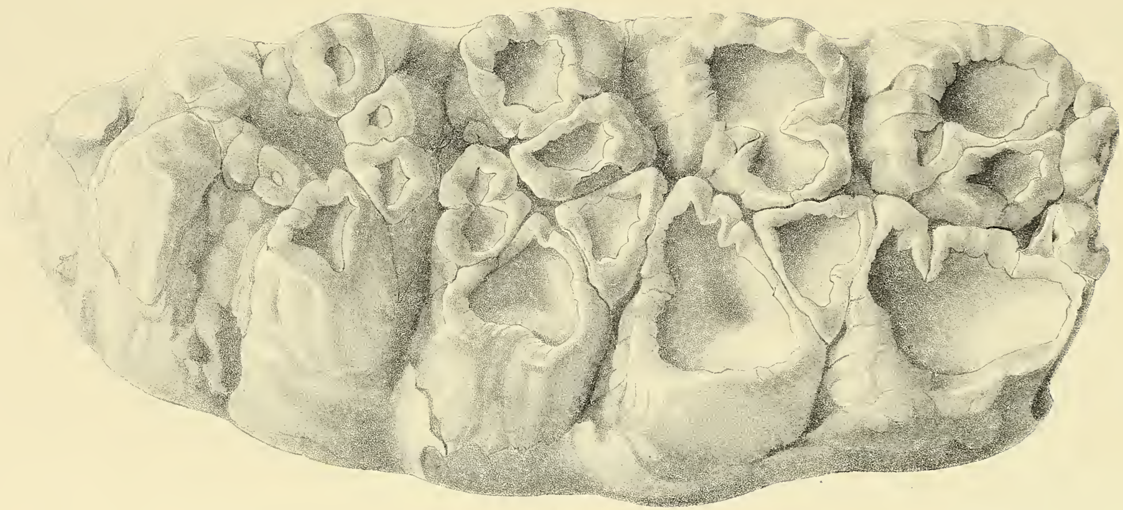

4.

J. Schaumburg Lith.ª

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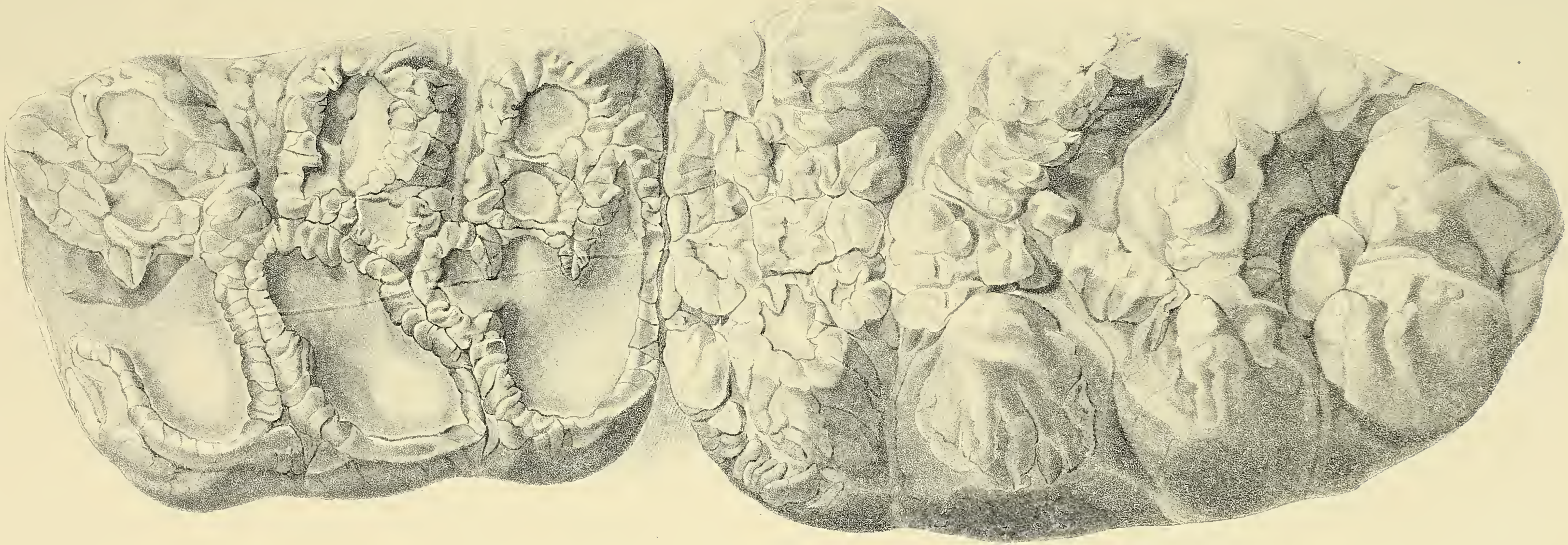
PLATE XXXVA.

Mastodon (Trilophodon) pandionis, Falconer.

The penultimate and last left upper true molars: from the Punjab: taken from a palate specimen.

The teeth are drawn of the natural size, and from the inner side.



J. Schaumburg, Lithd

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PLATE XXXVI.

MASTODON (TRILOPHODON) PANDIONIS, Falconer.

Fig. 1. The symphysis of the mandible, from the specimen containing the tooth represented in Plate XXXV, fig. 4.

Fig. 2. The symphysis of a mandible with tusks: from the Punjab.

Both figures are half the natural size.

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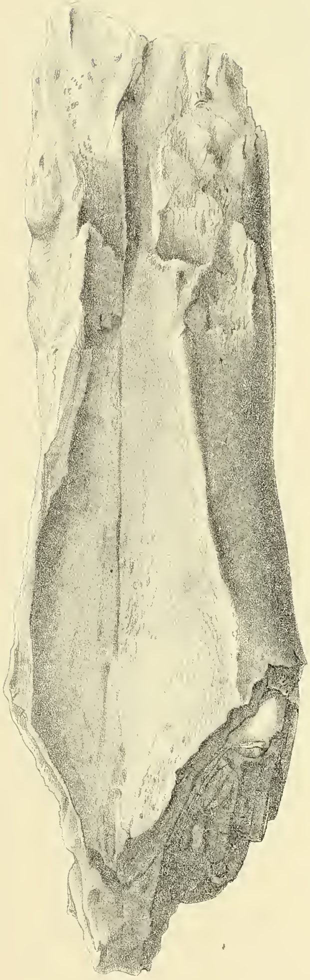

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J. Schaumburgur Lith^d. Printed at Geol: Survey Office

PLATE XXXVII.

MASTODON (TETRALOPHODON) LATIDENS, Clift,
and
MASTODON (TRILOPHODON) PANDIONIS, Falconer.

The specimen drawn in fig. 3 is provisionally referred to *M. pandionis:* all the other specimens belong to *M. latidens.*

Fig. 1. The third right lower milk-molar: from Burma?

Fig. 2. The second right lower milk-molar: from the Punjab.

Fig. 3. The second left lower milk-molar: from Sind.

Fig. 4. The second right upper milk-molar: from the Punjab.

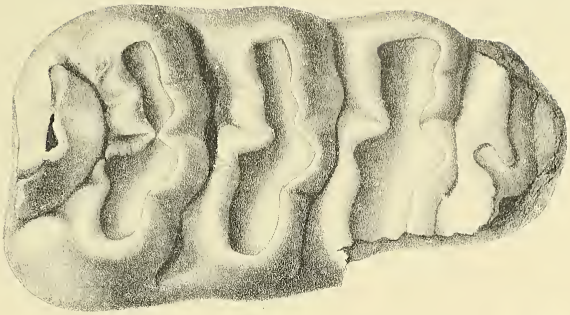
Fig. 5. The first left upper milk-molar: from the Punjab.

Fig. 6. The last left upper premolar: from the same jaw as No. 8.

Fig. 7. The penultimate right upper premolar: from the Punjab.

Fig. 8. The third left upper milk-molar: from the Punjab.

All the specimens are represented of the natural size. The upper molars are viewed from the inner, and the lower from the outer side.



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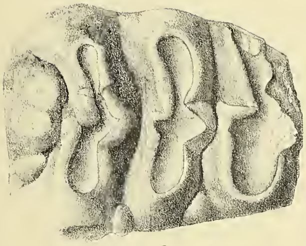

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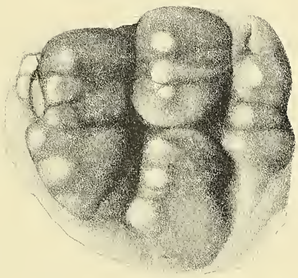

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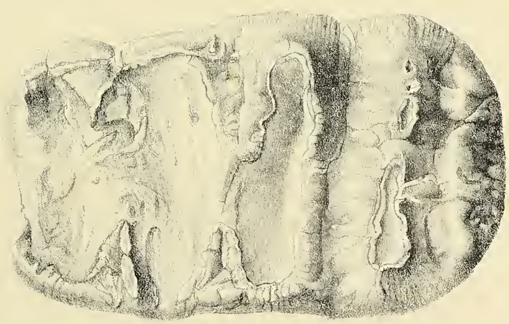

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PLATE XXXVIII.

MASTODON (TETRALOPHODON) LATIDENS, Clift.

Fig. 1. The second right upper true molar: from the Punjab.

Fig. 2. The second right upper true molar: from a palate specimen from Burma.

Both molars are represented of the natural size: and are viewed from the inner side.

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PLATE XXXIX.

Mastodon (Tetralophodon) latidens, Clift.

The third right upper true molar: from Lehri, in the Punjab. The specimen is drawn of the natural size, and is viewed from the inner side.

1

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PLATE XL.

Mastodon (Tetralophodon) perimensis, Falc. & Caut.

Fragment of left maxilla containing the last premolar, and the first true molar: from the Punjab. The specimen is drawn of the natural size.

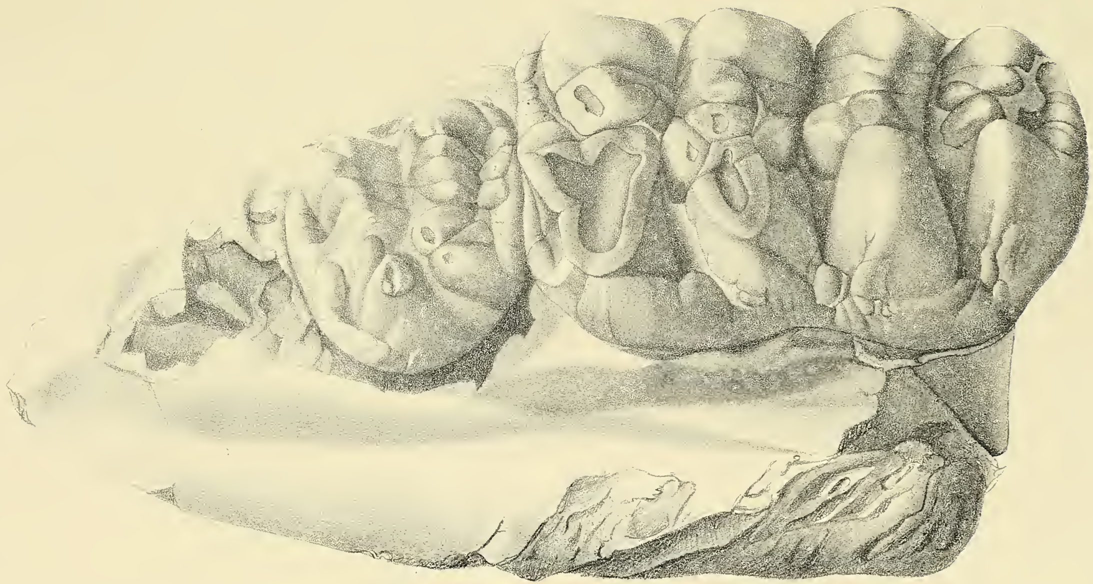

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PLATE XLI.

Fig. 1. MASTODON (TETRALOPHODON) PERIMENSIS, Falc. & Caut. Second left lower true molar: from the Punjab.

Fig. 2. MASTODON (TETRALOPHODON) SIVALENSIS, Falc. & Caut. Third left upper milk-molar: from the Siwaliks.

Fig. 3. MASTODON (TETRALOPHODON) PERIMENSIS? Falc. & Caut. First right upper milk molar: from the Punjab.

Fig. 4. MASTODON (TETRALOPHODON) PERIMENSIS, Falc. & Caut. Second right upper true molar: from the Punjab.

All the specimens are drawn of the natural size. The upper molars are viewed from the inner side. The lower molar is viewed from the outer side.

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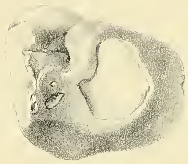

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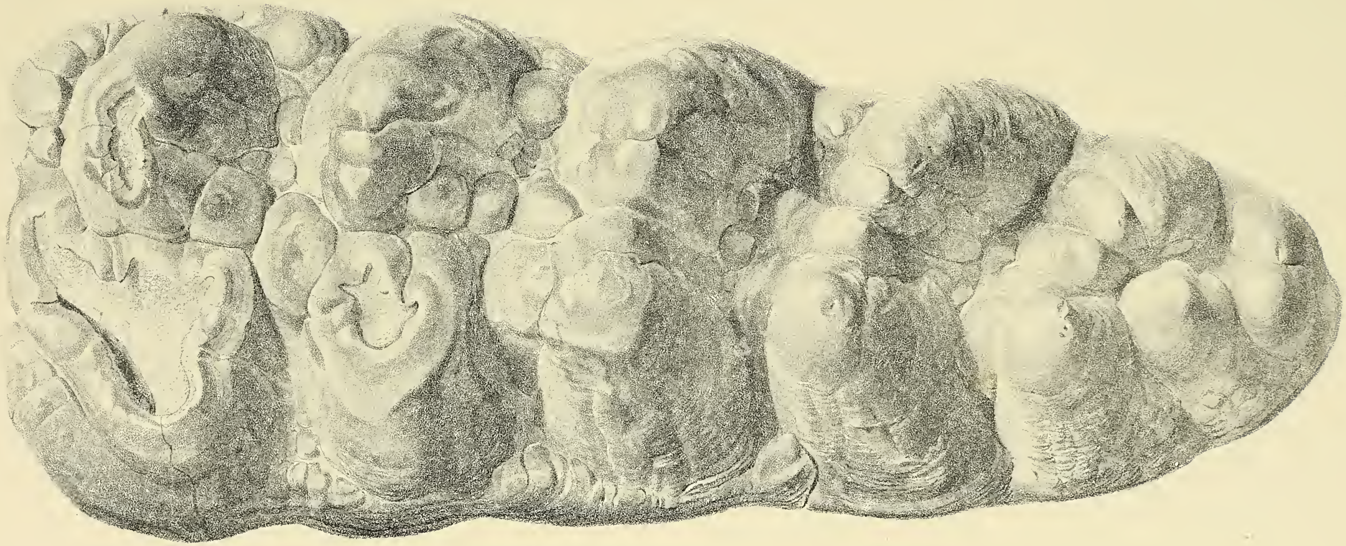
J. Schaumburg Lithd. Printed at Geol: Survey Office

PLATE XLII.

Mastodon (Tetralophodon) perimensis, Falc. & Caut.

Third left upper true molar: from the Punjab: drawn of the natural size, and viewed from the inner side.



J. Schaumburg, Lith^{d}

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PLATE XLIII.

Fig. 1. Mastodon (Tetralophodon) perimensis (?) Falc. and Caut. Symphysis of mandible.

Fig. 2. Mastodon (Tetralophodon) perimensis, Falc. and Caut. Symphysis of mandible broken anteriorly, and showing in cross section two small tusks.

Both specimens were obtained from the Punjab, and are represented of half the natural size.

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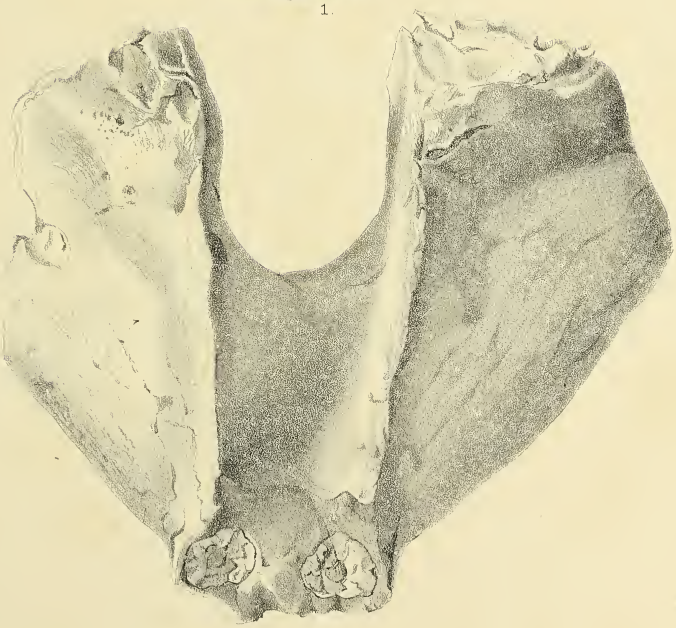

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J. Schaumburg Lithd.

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PLATE XLIV.

MASTODON (TETRALOPHODON SIVALENSIS), Falc. & Caut.

Fig. 1. Third left upper true molar: from a palate specimen collected in the Punjab.

Fig. 2. Third right lower milk-molar: from a fragment of a mandible collected in Kangra.

Fig. 3. Third right lower true molar: from a nearly complete palate collected in the Punjab.

The specimens are figured of the natural size, the upper molar being viewed from the inner and the lower molars from the outer side.

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J. Schaumburg, Lith.

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PLATE XLV.

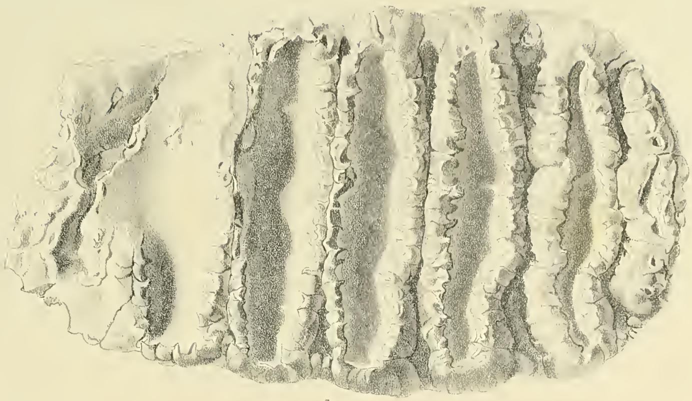
Fig. 1. STEGODON CLIFTII, Falconer and Cautley. Third left upper milk-molar: from the Punjab.

Fig. 2. (?) STEGODON CLIFTII, Falconer and Cautley. Second right upper milk-molar: from China. *Stegodon sinensis,* Owen.

Fig. 3. STEGODON BOMBIFRONS, Falconer and Cautley. Third right lower milk-molar: from the Punjab.

Fig. 4. STEGODON INSIGNIS, Falconer and Cautley. Third upper milk-molar: from the Punjab.

All the figures are drawn of the natural size, the upper molars being viewed from the inner and the lower from the outer side.



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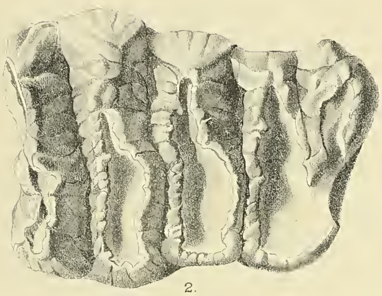

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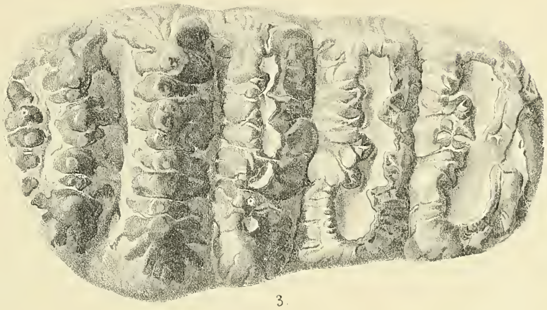

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J. Scaumburg Lithª Printed at Geol: Survey Office

PLATE XLVI.

Fig. 1. Stegodon bombifrons, Falconer and Cautley. First left upper true molar.

Fig. 2. Stegodon insignis, Falconer and Cautley. Second left lower milk-molar.

Fig. 3. Stegodon bombifrons, Falconer and Cautley. Second left lower milk-molar.

Fig. 4. Stegodon insignis, Falconer and Cautley. Third right lower true molar.

All the figures are drawn of the natural size, the upper molar being viewed from the inner, and the lower molarsfrom the outer side. All the specimens are from the Punjab.

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